ENERGY CONSERVATION IN BUILDINGS

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HEARINGS

BEFORE A

SUBCOMMITTEE OF THE

COMMITTEE ON

GOVERNMENT OPERATIONS
HOUSE OF REPRESENTATIVES

NINETY-FOURTH CONGRESS

SECOND SESSION

JULY 27 AND 28, 1976

Printed for the use of the Committee on Government Operations





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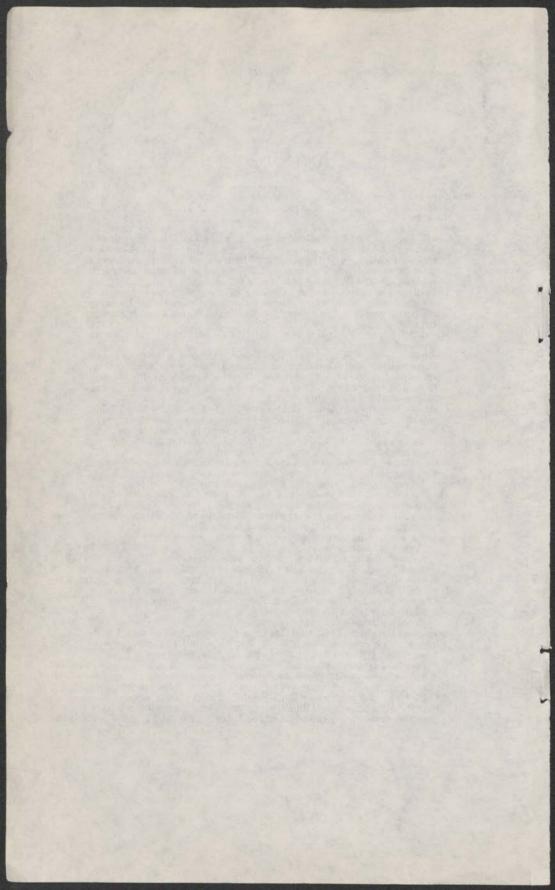
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ENERGY CONSERVATION IN BUILDINGS

TUESDAY, JULY 27, 1976

House of Representatives,
Conservation, Energy,
and Natural Resources Subcommittee
of the Committee on Government Operations,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10:10 a.m., in room 2247, Rayburn House Office Building, Hon. Leo J. Ryan (chairman of the subcommittee) presiding.

Present: Representatives Leo J. Ryan and Gilbert Gude.

Also present: Norman G. Cornish, staff director; Robert K. Lane, assistant for energy; Ronald J. Tipton, assistant for environment; Eileen W. Theim, chief clerk; and Stephen M. Daniels, minority professional staff, Committee on Government Operations.

Mr. RYAN. The subcommittee will come to order.

Today the Conservation, Energy, and Natural Resources Subcommittee begins a series of hearing on Federal energy conservation efforts, with particular emphasis on the progress being made in increasing the energy efficiency of buildings.

There is no place in this society where we find a greater disparity between what we are supposed to be doing and what we are actually doing than in the Federal Government. And the Federal Government

should be taking the lead and setting the example.

For example, the Congress says that we shall drive no faster than 55 miles per hour. This causes great difficulty and stress for the millions who are engaged daily in jobs requiring driving. Anybody who has driven from here to San Francisco or from San Francisco to Denver on the interstate freeways at 55 miles per hour has to realize

that the Federal Government goofed again.

These people are being required to drive 55 and given tickets if they go over that. And yet, there are no penalties for the enormous waste in both the cost of manufacturing and the cost of using buildings. And I do not refer to dollar costs; I refer to energy costs. And that is what this committee is going to pursue—the energy costs and the cost inefficiency, and what the Federal Government is doing about it in trying to set policy to change it around.

There are many in this country who are concerned that the Federal Government has not made energy conservation the top priority emphasis it deserves. I am one of them. Many feel that Federal energy efforts are fragmented, uncoordinated, and, frankly, ineffective.

There are good reasons for this criticism. Since the days of the Arab oil embargo, we have seen very few substantive changes in the way we live. Americans continue to consume and waste massive

amounts of energy as if there were no tomorrow. We apparently have

learned little from our past experience.

Nevertheless, we have heard much talk in recent years from various Federal officials about energy independence and energy self-sufficiency and how we must prepare ourselves against future oil embargoes. Just recently, however, petroleum imports to this country reached a record high of 40 percent—and we are still going higher. And I contrast that with the dependency in about 1973 of 25 percent. We are not going in the right direction.

Even though the Federal Government has established a goal of reducing oil imports, the situation is worsening daily. We are going to need more than broad platitudes to make energy independence a

In the face of such poor results, it is not surprising that the head of the Federal Energy Administration has been quoted as saying that

energy conservation in this country is a joke.

Through these hearings today, we hope to be able to determine why energy conservation has become a joke and why so little progress has been made toward development of an energy conservation ethic.

We will pay particular concern to one key area of energy conservation which, in my estimation, has been the most neglected-that of energy conservation in buildings. It is surprising how many agencies are involved in improving energy conservation in buildings. The Federal Energy Administration is working on the problem. So is the Energy Research and Development Administration, the National Bureau of Standards, the General Services Administration, the Department of Housing and Urban Development, and on and on and on.

Millions upon millions of Federal dollars have been spent by Federal agencies to improve energy conservation in buildings. Millions more will be spent this year. The big questions today are: What has the taxpayer received in return? What progress is being made? When will we see the turning point to improved energy conservation in this country as a result of the Federal efforts? Is the Federal Government setting a proper example in energy conservation for the rest of the Nation to follow?

I hope before these hearings are over we will have some answers to these and other important questions concerning the Federal role in

energy conservation.

This morning we will hear from four witnesses. The first witness will be Mr. Robert Hemphill of the Federal Energy Administration.

Next we will hear from Roger Sant, former Assistant Administrator for Conservation and Environment of the FEA. And finally, we

will hear from two distinguished architects.

I would like, before you begin, to make one final personal comment. The consumer is daily being told to spend more money to buy a device to stick on the exhaust pipe of his car to clean it up; he is being told to change the volume of water in the plumbing in his bathroom; he is being told to do all kinds of things, including to go along with a lower speed limit.

But I do not see what large agencies, including private as well as public, but especially public, are being required to do so far by com-

parison. And that is what I am interested in hearing.

I want to know about the short-range plans—those bits of patchwork and pasteup and the rest that are going to get us through the next 2 or 3 or 4 years. But, beyond that, I want to know what specific changes are now planned in the construction of buildings in this country and in the construction policies of this country that will significantly and drastically change the present system of operation.

I will give you one more example. My district includes the San Francisco Airport. The San Francisco Airport is 22 miles, as the taxicab flies, from downtown San Francisco. And the Federal Government has all kinds of regional headquarters in San Francisco. But I know of no plans in the Federal Government to change those regional headquarters from San Francisco to the airport—not just in the sense of providing a few heads of agencies down there, but in the sense of changing policies so that a person who has to fly in or out can fly in and spend a couple of hours there without worrying about transportation; so that he could have his meeting and get back home on the same day without using transportation back and forth because that is the way it has always been done.

I know of no agency in the Federal Government that is even talking about any kind of change. And I am not speaking of permanent buildings, such as the Federal Court Building, which are already built in San Francisco. I am talking about the rentals and the leasings and the future leasings to meet Federal Government needs in the San

Francisco Bay area.

As far as that goes, nothing has been done in Oakland either. Oakland has an international airport. But nothing of any kind has

been done there either.

The transportation around municipal airports and international airports, whether in San Francisco or in New York City, is incredible. Why should one go from JFK or La Guardia to downtown New York City to find some agency administrator—when he could better be placed out at the airport? If he were there, one would not have to fight the cost of transportation or the cost of gasoline or the cost of time or the cost of buildings built. This indicates to me a total lack of concern on the part of the Federal Government.

And this is what we are after in this subcommittee. I guarantee you that where we find not enough progress being made, we are going

to harass the daylights out of those who are involved.

I want to see the Federal Government actively involved in specific and particular change—change to be accomplished as soon as possible; change beginning today or tomorrow; and, change being made with this committee's urging and encouragement for positive results.

And I will guarantee you a pretty hard tongue lashing at least where there is not what we think to be satisfactory progress.

With that, Mr. Hemphill, you may begin your testimony.

STATEMENT OF ROBERT F. HEMPHILL, JR., ASSOCIATE ASSISTANT ADMINISTRATOR, ENERGY CONSERVATION AND ENVIRONMENT, FEDERAL ENERGY ADMINISTRATION; ACCOMPANIED BY DAN C. QUIGLEY, DIRECTOR, BUILDINGS POLICY AND ENERGY CONSERVATION; AND ROBERT JORDAN, ASSOCIATE ASSISTANT ADMINISTRATOR, MARKETING

Mr. Hemphill. I think this opportunity to appear before you to discuss energy conservation in buildings is particularly useful from our point of view because I assure you that a number of us in the Federal Government who are directly concerned with energy conservation share the feelings which you have so aptly expressed.

In the buildings sector, conservation generally means two things. First, it means a set of capital investments in existing facilities which tighten up building shells, and make heating and cooling equipment more efficient, and thus paying for themselves in a predictable number of years. This sort of conservation, in short, is nothing more than capital investment justifiable on traditional economic grounds. Training, education, and information programs for the owners and operators of commercial and residential buildings are typical of the second

sort of conservation in existing buildings.

Conservation in buildings in the United States will not be a simple matter. In many respects, it will be more complex and difficult than encouraging increased domestic energy production. While only several thousand companies produce and distribute our energy, millions of businesses, institutions and individuals consume it. Still, it is vital to make the effort because 37 percent of all energy used in the United States is consumed in the buildings sector. The Nation's 67 million occupied housing units, of which some 47 million are single-family homes, account for 70 percent of the energy need in the buildings sector.

Commercial and other nonresidential structures account for the remaining 30 percent of the energy consumed in the buildings sector. Typical of these structures are office buildings, warehouses, educational buildings, hospitals, and State and local public buildings and colleges. Altogether, there are 24 billion square feet of commercial space. These buildings serve a wide variety of functions. Moreover, their ownership is often backed by complicated financial arrangements. For these reasons, achieving energy conservation in the commercial sector is particularly complicated.

In January 1975, the President proposed a number of measures addressed to energy conservation in buildings. He stressed that cutting long-term energy consumption was just as important as increasing energy supplies. He proposed a bill to make thermal efficiency standards mandatory for all new residential and commercial buildings; he proposed a new tax credit of up to \$150 for homeowners who install insulation; and he proposed a program to weatherize 1.5 million low-income family homes.

I would add parenthetically that we think that some or all of those proposals would have at least started us toward the significant and drastic changes which you mentioned earlier in your statement.

Eighteen months later, we do not have the tax credit; we do not have mandatory building standards; and, we do not have a weatherization bill. We are hopeful that these measures will be passed in some form before Congress adjourns this fall. This is an especially serious matter for the low-income families in the Nation. Those families of four, with annual incomes of only \$5,500 per year, spend an estimated 11 percent of that income on home energy use—or about \$600.

FEA is ready to quickly implement the weatherization program. Without the program, high energy bills will force many of these families to cut back on basic necessities in order to keep warm in winter.

These Presidential proposals are, by and large, Government incentives to encourage private action. The Administration also recognizes there is a lack of reliable information on the costs and benefits of specific conservation measures and has consequently instituted programs which would provide such information to the private sector.

Because energy conservation is in the economic self-interest of virtually all energy users, our programs have emphasized the provision of detailed information on proven conservation measures rather than arbitrary controls on energy use. The intent of the programs has been to reduce energy consumption to the maximum extent possible with existing technology, while also minimizing the cost to the Government.

Mr. Chairman, we have prepared a document which describes our programs, and which I would like to summarize and include as part of the committee's record. It is entitled, "Buildings Programs—Energy Conservation and Environment." I would also like to submit to you a copy of the first quarterly report on FEA energy conservation programs which we provided to the House and Senate Committees on Appropriations in April of 1976.

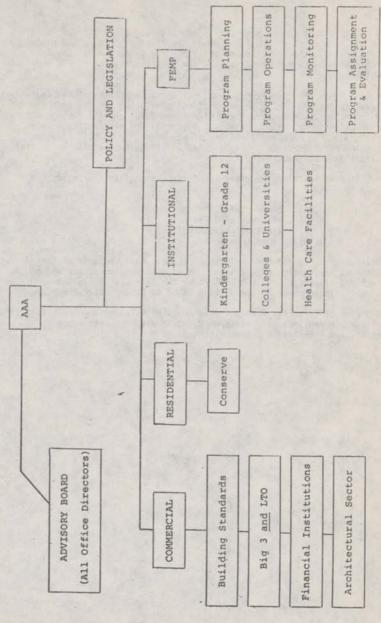
[The material follows:]

OFFICE OF BUILDINGS PROGRAMS

ENERGY CONSERVATION AND ENVIRONMENT

COMPENDIUM 1976

BUILDINGS PROGRAMS
ENERGY CONSERVATION AND ENVIRONMENT



BACKGROUND

The objectives of the Federal Energy Administration's Office of Buildings Programs, Conservation and Environment are to contribute to the maximum extent possible the reduction of buildings energy demand growth; to do this with minimum adverse impact; and to accomplish it in the shortest feasible time.

The Office of Buildings Programs has set out to accomplish these objectives by developing, organizing and demonstrating existing and new techniques and technologies to encourage and permit immediate and increasing conservation in buildings. The vast potential for eliminating energy waste and making more efficient use of needed energy in buildings is being addressed by projects for new and existing commercial, residential, institutional and Federal buildings.

The Office of Buildings Programs is disaggregated into four major sub-sectors which cover total energy use in buildings:

(A) Commercial Buildings
 (B) Residential Buildings
 (C) Institutional Buildings
 (D) Federal Buildings

However, there are existing buildings programs that, because of their subject matter, extend beyond the scope of a single sub-sector and are directly pertinent to all sub-sectors of the Office of Buildings Programs. These programs are distinguished as Cross-Sector Programs.

The Office of Buildings Programs also contains a Policy and Legislation Office which provides general support in the areas of both economic analysis and legislative policy alternatives.

A. COMMERCIAL BUILDINGS PROGRAMS

Programs under this sub-sector address themselves to the energy consumption of both new and existing commercial buildings which includes office and bank buildings, retail establishments, supermarkets, shopping centers, hotels, laboratories and public buildings. The commercial sub-sector is especially attuned to the great variations in design, use, equipment, operation, quality of construction, size and institutional framework. Commercial buildings are responsible for 30 percent of the total annual energy consumption by buildings; therefore, it is the objective of the programs in this sub-sector to formulate energy conservation procedures and methodologies that will effectively reduce the energy consumption of all types of commercial buildings, emphasizing overall building design as well as efficient equipment, maintenance and operation.

Program Descriptions:

Buildings Energy Management Workshops

The FEA Workshops Programs are focused on three critical areas of energy use in the commercial sectors of the Nation's economy:

- Energy consumed in the operation and maintenance of commercial and industrial administrative office space (Buildings Energy Management Workshops);
- Energy consumed in industrial and manufacturing processes and operations (Industrial Energy Conservation Workshops);
- c. Energy consumed in transporting employees between work site and residence (Vanpooling Seminars and Workshops).

The Buildings Energy Management Workshops is a one-year program during which approximately 140 workshops will be conducted and aimed at the owners, operators, and major tenants of large buildings or building complexes. They will cover opportunities for, and the economics of, improved energy management in the operation of buildings. Included will be coverage of lighting, heating, cooling, ventilation, insulation and energy-related utilities associated with the operation of commercial buildings.

II. Lighting and Thermal Operations Awards Program

The Lighting and Thermal Operations (LTO) Awards Frogram is designed to encourage and recognize outstanding levels of energy savings through implementation of Lighting and Thermal Operations Programs in commercial buildings.

Awards are made on the basis of annual energy savings determined by comparing kilowatt hours consumed in the previous year, adjusted if necessary, for substantial changes in mix and/or production levels. Savings of 30-35 percent qualifies an applicant for a Merit Award, savings of more than 35 percent qualifies an applicant for an Excellence Award.

Currently efforts are being made to effectively incorporate the LTO Awards Program into the Buildings Energy Management Horkshops Programs as an additional incentive to building owners, operators and major tenants to implement an efficient energy conservation management program within their own buildings.

B. RESIDENTIAL BUILDINGS PROGRAMS

Of the total United States' energy consumed in 1975, 37 percent was consumed in the buildings sector. Residential structures consume 70 percent of the energy consumed in the buildings sector. These structures include single-family, multi-family, low and high rise, and mobile homes. In an effort to reduce the energy consumption of residential buildings and provide homeowners with specific technical and financial information, FEA is working with twelve state governments to implement several different programs. Participating states were selected on the basis of proposals submitted from twenty-four states.

Program Descriptions:

I. Project Conserve

Two of the states, Massachusetts and New Mexico, are conducting PROJECT CONSERVE, a computerized cost and savings system involving distribution of a simple questionnaire to single-family homeowners. Persons who participate by completing and returning the twenty-nine question form receive an analysis of their homes' thermal characteristics and up to five recommendations for home improvements. Do-It-Yourself and contractor costs for the actions and estimates of the payback period for each are included as well as an estimate of the energy-conserving potential.

II. Home Energy Savers Program

Eight states (Connecticut, Rhode Island, Maryland, Tennessee, South Carolina, Nebraska, Utah and Ohio) and two partial states (ten northern counties in Illinois and Chautauqua County, New York) were selected to implement alternative programs to promote residential energy conservation. Most of the programs will be centered around a workbook enabling homeowners to evaluate and compute the energy efficiency of their own homes. The workbook currently is under development. A 30 minute retrofit film for Public Service Television viewing will support the workbook, along with a media campaign.

III. Energy Evaluation of Residential Buildings Using Interactive Computer Graphics

Cornell University is currently developing graphic input capabilities which fully describe the thermal envelope of a single family, multizoned residence for energy evaluation. The use of interactive graphics provides immediate feedback as well as the ability to edit, delete, modify, substitute or change elements in a building design.

The capability of dynamic display allows the unskilled user to manipulate, rotate, or translate a building as well as to visually check its size, location, and dimension.

IV. Energy Conservation in New Construction

With contractor assistance, the Residential Buildings Programs Office will develop and disseminate a manual for home builders on energy conservation in new residential construction. The manual will cover design, construction and marketing and will include case studies of successful conservation-conscious builders.

VI. Retrofit Business Guide Program

With contractor assistance, a guide for people who may wish to expand their current business or start a new business in the field of residential retrofit is being prepared. The guide will incorporate information on both materials and techniques for energy conserving improvements, as well as tips on how to efficiently and successfully operate such a business.

C. INSTITUTIONAL BUILDINGS PROGRAMS

This program involves the educational community, hospital and nursing home facilities, detention centers, and religious buildings to seek the most expeditious measures for energy conservation; to organize and publicize these measures; and to advise as to how they might implement energy conservation methods in their various institutions. Institutional buildings of the type mentioned above are responsible for 11 percent of the total United States annual energy consumption. Institutional facilities are at a disadvantage since it is very difficult for them to pass through the inordinate increase in their energy costs, where as the private sector is more able to do so by adding the energy cost to the cost of their products or services. Therefore, because of their unique situation, it is the objective of this program to strongly publicize and encourage the actual demonstration and implementation of energy conserving alterations, practices and methodologies for institutional buildings.

Program Descriptions:

The Public Schools Energy Conservation Services (PSECS)

In September 1974, through FEA funding, Education Facilities Laboratories, Inc. developed what is now known as PSECS. PSECS is a computer based technical service designed to help and encourage school districts improve their facilities and equipment. The Federal Energy Administration has agreed to provide limited funding for test marketing of the elementary school package in selected school districts in order to refine the process, determine the costs involved in operating PSECS, and further develop procedures that can be used in full scale marketing activities.

This service will inform a district (1) what the present level of energy use is in each of its schools; (2) what the energy use should be in each school, and (3) how to proceed to achieve suggested energy use levels.

 Energy Conservation Workshops for the Public Schools - Kindergarten through Twelth Grade (K-12)

The Office of Buildings Programs is sponsoring a program of ten (10) two-day intensive workshops (one in each Federal region) for energy conservation in facilities for a national audience of selected public elementary and secondary school administrators, school business officials and school building operations and maintenance administrators and

supervisors. The workshops will emphasize to those who use educational facilities awareness of the methods of energy conservation now known. and will provide opportunities for workshop participants to identify and develop solutions for energy-wasting problems in their own schools. The ultimate goal of the workshops is to stimulate, encourage, and persuade the attendees to institute or influence the institution of vinorous energy conservation programs. The program will use sound, practical, useful facts and procedures to achieve this goal.

III. Energy Conservation Morkshops for Colleges and Universities

The National Association of College and University Business Officers (NACUBO) will conduct a series of workshops to inform business officers and physical plant administrators of institutions of higher education of a campus energy management program. Its purpose will be to assist in the efficient use of energy by colleges and universities, develop awareness of programs now in operation and provide the impetus for implementing an effective energy conservation program on campus.

IV. Saving Schoolhouse Energy

The American Association of School Administrators will fully retrofit ten elementary schools across the country as a demonstration of what can be done in all existing school buildings. The project will be conducted in five phases, commencing with a complete energy efficiency study of the facility, continuing with archtectural-engineering modification studies, implementation of the suggested modifications, monitoring of the savings achieved by the modifications, and dissemination of the data. AASA will also prepare comprehensive reports on the entire process to assist other school districts in replicating the program.

V. Manual for Health Care Facilities

After a year's study and work with six hospitals in the Philadelphia area, the University City Science Center has produced a "Manual for Practical Energy Management in Health Care Institutions." Its Executive Summary provides a quick means of alerting hospital administrators as to the energy problems their institutions face, and the balance of the 85-page document contains techniques, methods and suggestions on how to carry out comprehensive energy management in hospitals of various sizes and types. This last section is aimed at hospital engineers and plant managers. We are now negotiating the printing of this document, and it should be available soon.

We plan to use the manual as a textbook in a series of regional workshops for hospital administrators and plant personnel, to be held during the fall and winter of 1976-77; this second phase is still in the planning stages, however.

D. FEDERAL ENERGY MANAGEMENT PROGRAM

The Federal Energy Management Program (FEMP) is responsible for developing policy recommendations, promoting, monitoring, and documenting energy savings in the Federal Government. The Federal Government is the largest single purchaser of energy in the Nation, and FEMP, as manager of the Government energy conservation effort, has become a testing and demonstration area where it is being shown that conservation can be successful and highly cost effective.

Through FEMP, energy use in the Federal Government was reduced by over 24 percent in FY 74 and FY 75. In FY 76, Federal energy use is currently 5 percent under actual FY 75 consumption levels. This is a cumulative energy savings equivalent to over 250,000 barrels of oil per day.

Additional major energy savings will involve relatively complex and cost effective capital investments. FFMP, working with other Federal agencies, will be developing plans, programs and actions to achieve an optimal energy savings level for the Federal Government.

Program Description:

Under Congressional mandate and Presidential direction, FEMP is charged with developing a 10-year plan for increasing the energy efficiencies of Federal facilities. This activity will include the development of mandatory building and lighting efficiency standards, guidelines relating to the hours of operation and operating procedures of Federal buildings, preparing guidelines for planning, identifying, setting priorities and budgeting retrofit activities.

In addition, FEA, through FEMP, has entered into interagency agreements for the implementation and demonstration of energy management systems, effective driver training, and architectural and engineering facilities surveys. FEMP is also developing energy educational materials for inclusion in existing Federal training programs. Assistance to other agencies is provided through site visits to Federal installations which serve to demonstrate successful techniques and activities as well as identify potential problem areas.

Through FEMP, FEA has published "Energy Conservation Site Visit Report: Toward More Effective Energy Management" and periodic reports on the progress and results of the Federal energy management effort.

E. CROSS-SECTOR PROGRAMS

The building industry has various components and organizations that govern the construction, finance, use, operation and maintenance of buildings regardless of type (commercial, residential, or institutional). The Office of Buildings Programs recognizes this and has established "Cross-Sector" Programs that address themselves to these components and organizations in order to expedite energy conservation in all buildings. The programs in this area address themselves to building codes, architectural design procedures, financial institutions, and state legislative stipulations regarding buildings.

Building Energy Standards Program

The building energy standards program achieves energy conservation through a promotion of greater efficiency design in new residential and commercial construction. The program relies on the adoption by states and local political jurisdictions of modern building standards and codes with which buildings, architects, engineers and builders must comply.

These energy standards take into consideration variables which make significant impact on the energy efficiency of new construction such as climatic conditions, site orientation insulation factors, heating, ventilation and air conditioning systems, electric power distribution and use, and habitability patterns.

As an example of an energy building standard, FEA is recommending the use of guidelines equal to, or better than, ASHPAE 90-75, specifically chapters 4 through 9 as they relate to a component performance of the standard.

The viability of the ASHRAE "type" component performance standard is indicated by projected energy savings over 1973 construction practices. These include 10 percent reduction in single family residences, 42.7 percent reduction in low rise apartment buildings, 59.7 percent reduction in office buildings, 40.1 percent reduction in retail establishments and 48.1 percent reduction in school buildings.

Program Description:

In pursuit of these energy savings, the Office of Buildings Programs has initiated a series of technical assistance activities which may be used by states in their own efforts toward the adoption and implementation of energy building standards.

FEA's program takes advantage of the technical development capability of organizations such as the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), research organizations such as Arthur D. Little and Booze Allen, engineering analysis from the National Bureau of Standards, and the structure of field programs through organizations such as the Council of American Building Officials, National Association of Counties, and League of Cities Conferences of Mayors.

Technical support contracts are also under consideration with selected states now directly involved in energy standards implementation. Results of these contracts would provide specific information as to how critical problems relating to implementation were overcome at the local level. This information will be shared with states and local code jurisdictions similarly concerned with standards implementation.

The standards program described above is seen as a forerunner to activities which may be funded under the state conservation program. The Office of Buildings Programs will be responsible for the development of major technical assistance elements as well as resource materials in the area of energy standards. The combination of experience indicated above should lend itself directly to an expeditious and effective standards program on the part of participating states.

II. Financial Institutions Program

In developing and field testing a number of energy conservation programs for buildings, it was observed that the real estate market mechanisms apparently give no value to a dwelling's energy efficiency. If the housing market is to operate efficiently, buyers and sellers must be capable of judging the price and quality

of particular housing units. It is possible for a rore thermally efficient home to have a higher initial cost than an identical home (same structure, location, and appliances) that has incorporated relatively few energy conservation measures. Yet the energy efficient dwelling costs less to operate. Thus, more disposable income could be directed to off-set the higher initial cost of the thermally efficient homes. It is apparent that the private market is not making adjustments for energy efficiency.

Due to such findings, the Federal Energy Administration is convinced that certain basic procedures for granting mortgage loans by financial institutions (which includes S&L's, Federal lending institutions, insurance companies, and mortgage bankers) must be altered to include thermal efficiency considerations. In particular, the procedures for appraisal of an improved property and debt service analysis are being rigorously investigated and a survey of current practices is about to get underway. The basic mission of this program is to investigate and offer alternatives to overcome barriers to energy efficient investment in the real estate sector.

Program Description:

The Financial Institutions Program has a two-fold objective. First, it will attempt to incorporate energy efficiency criteria and analysis procedures into private sector appraisal and mortgage service activities. Secondly, where Federal activities directly affect real estate financing, incorporation of energy efficiency criteria into the activities shall be attempted.

As envisioned, the program objectives will be realized through the following actions:

- demonstrate that building energy efficiency is in the cust interests of the real estate financial community;
- delineate cost to the Government for insuring or purchasing energy in efficient mortgages;
- develop criteria and analysis procedures for voluntary inclusion into appraisal and loan application forms;
- assist the building industry by means of educational program development and implementation.

III. Architectural Energy Conscious Design Program

Since all buildings require some architectural expertise and design, it is foreseen that incorporation of energy conscious design at the birth of the building on the architect's table would greatly enhance and expedite energy conserving techniques at the operational and maintenance levels. Therefore, it is necessary to develop a program that is geared to the involvement of architects in energy conscious design and practice.

Program Description:

The AIA Research Corporation has been retained to develop material and a program to bring energy conscious design into the mainstream of architectural practice and education. The work is divided into four programs directed toward the professional practice and university sectors of the architectural community.

The Professional Program is focusing on the determination of professional needs, development of materials and resources, testing workshop delivery mechanisms, and obtaining commitments to incorporate energy conscious design into the participants's professional practice.

The University Program is designed to initiate and encourage energy conscious design in architectural education, working with university faculities and administrators to identify incentives and constraints to energy conscious design to define information and program needs.

The Design Competition Program is focused on faculty and student awareness and participation in energy conscious design as well as encouraging dialogue between student and professor.

The AIA Convention Program for the Annual Convention held in Philadelphia in May 1976 incorporated materials from both the early competition and professional practice programs. These programs and materials were utilized in a series of displays and activities that encouraged convention attendees to contribute and react to ideas surrounding this important project.

POLICY AND LEGISLATION OFFICE

The Policy and Legislation Office assists in the preparation of requested Congressional testimony by FEA officials; engages in program evaluation and economic analysis within the Office of Buildings Programs; and provides staff support for the Thermal Standards Task Force of the Energy Resources Council.

Data collection and modeling efforts by the Policy and Legislation Office include energy savings estimates in several buildings programs, and residential and commercial modeling efforts being performed under contract to FEA at Oak Ridge Laboratories.

The Policy and Legislation Office maintains contract files for the Office of Buildings Programs; undertakes special projects such as the preparation of speech material for FEA officials on an intermittent basis, and maintains a library of energy material specifically related to the building industry.

The Policy and Legislation Office also performs staff work in support of the State Energy Conservation Program mandated by Congress in the Energy Policy Conservation Act of 1975.



NOTE:

Attachments 1, 2, and 3, indicated by footnotes on pages 17, 19, and 21 of the First Quarterly Report, will be sent under separate cover as soon as additional copies are returned from the printer. All three attachments/reports are expected to be available within two weeks.

First Quarterly Report to U.S. House and Senate Committees on Appropriations

April 1976

Federal Energy Administration Energy Conservation Programs



prepared by Energy Conservation and Environment Office of Planning, Analysis and Evaluation

INTRODUCTION

This is the first of a series of quarterly reports to the House and Senate Committees on Appropriations describing the progress of the Federal Energy Administration's (FEA) energy conservation programs and short- and long-term accomplishments in terms of the dollar and energy savings that result from the programs. This report has been prepared in response to the directions of the Committees published in the House Committee Report (Report No. 94-374) and the Conference Report (Report No. 94-701) on "Making Appropriations for the Department of Interior and Related Agencies, Fiscal Year 1976." Part A, Overview, of this report discusses the rationale underlying the selection and design of the programs, briefly describes the major programs, and summarizes the estimated short- and long-term dollar and energy savings (pages 10-13) and costs (page 14) associated with the major programs. Part B, Highlights, reports the current status of the programs, including indicators of energy conservation achieved to date (pages 15-17), and major activities conducted during the quarter (pages 17-22). Part C lists major publications (pages 23-33).

Part A of the report is intended to serve as a background description of FEA's energy conservation programs. It will be modified whenever new programs are established by either legislative or administrative action, when new directions are established for existing programs, or when the energy savings and costs associated with the programs change significantly. Part B is intended to highlight the achievements and activities of the major programs during the quarter.

This report is for the quarterly period October through December 1975; and highlights major program activities that occurred between October 1975 and February 1976. Future quarterly reports will focus on the energy savings and costs associated with FEA's energy conservation program and the achievements and activities of major programs during the quarter.

A. OVERVIEW

FEA's energy conservation programs are conducted by the Office of Energy Conservation and Environment (EC&E). EC&E's overall energy conservation goals are to improve efficiency in the use of energy resources and thereby reduce the energy demand growth rate in the United States. In this context, EC&E develops and oversees the implementation of energy conservation programs that promote the efficient use of energy and ensure that environmental concerns are balanced with national energy goals.

EC&E's energy conservation programs are directed towards five major targets: the three major end-use consuming sectors (residential/commercial, industrial, and transportation), utilities, and the Federal Government. As Exhibit 1 indicates, of the total gross primary energy used in the United States in 1974, 20 percent was consumed directly in the residential/commercial sector, 28 percent in the industrial sector, 25 percent in the transportation sector, and 27 percent by utilities. If the electricity generated by utilities is allocated to the three end-use consuming sectors, also displayed in Exhibit 1, the residential/commercial sector consumes 36 percent of the total gross energy used in the United States, the industrial sector, 39 percent, and the transportation sector, 25 percent. Exhibit 1 also indicates that more than 14 quadrillion (10¹⁵) Btu's are lost in the generation of electricity. Of special interest is

Exhibit 1
United States 1974 Total Gross Consumption of Primary Energy*Resources by Major Consuming Sectors

	Total Gross Energy Inputs	Electricity Distribution	Electrical Loss Distribution	Total Energy Usage
Residential/Commercial	14,434 (19.8%)	3,420	8,277	26,133 (35.9%)
Industrial	20,455 (28.1%)	2,348	5,679	28,484 (39.1%)
Transportation	18,029 (24.7%)	60	145	18,234 (25.0%)
Electrical Generation	19,929 (27.4%)	_		
Total	72,847 (100%)	5,828	14,101	72,851 (100%)

SOURCE: Federal Energy Administration, Monthly Energy Review, February 1976.

Primary energy is energy measured before conversion to another form;
 e.g., when coal is converted to electricity, the coal is the primary energy

the fact that the Federal Government consumes more than 2 percent of the total energy used and has already manifested a significant potential for energy savings.

The nature of the policy analysis that EC&E conducts in support of its programs is outlined briefly below, followed by a description of EC&E's environmental programs. The report then focuses on specific EC&E energy conservation programs.

POLICY ANALYSIS*

EC&E conducts policy analysis to identify opportunities for energy conservation, to analyze specific policy options for achieving those opportunities, and to develop new energy conservation programs. EC&E will also conduct evaluations of all major program activities. (The results of the evaluations will not be available for several months.) In performing these functions, EC&E has helped to support various data collection efforts and has analyzed available data on energy demand and consumption as well as the economic aspects of energy use and conservation. Policy analysis is generally conducted in support of the five major energy conservation program areas previously defined as residential/commercial, industrial, and transportation sectors, utilities, and the Federal Government. In addition, EC&E sponsors or conducts a number of special cross-sector studies, such as capital requirements for energy conservation investment over the next decade, detailed comparison of United States and Western European energy use, energy consumption measurements (a study being conducted by the National Academy of Sciences), economic and energy impacts of mandatory deposit beverage container legislation, land use and energy conservation, and the energy conservation potential in existing metropolitan communities.

ENVIRONMENT

EC&E conducts three broad environmental programs. One program assesses the energy impact of environmental laws and regulations and recommends appropriate changes which balance energy goals with

^{*} Policy analysis, as used in this report, refers solely to policy analysis conducted by EC&E in support of its program.

environmental concerns. For example, EC&E has assessed the technical and policy implications of proposed Clean Air Act amendments under consideration by the Congress as they would affect the electric utility industry.

A second environmental program evaluates alternative energy resource development policies and legislative proposals, such as surface mining legislation, proposed domestic energy development, the Federal coal leasing program, coastal zone management programs, outer continental shelf petroleum development plans, synthetic fuel development activities, and geothermal and nuclear development activities.

Through the third program, FEA fulfills its responsibilities under the National Environmental Protection Act (NEPA) by reviewing and commenting on environmental impact statements (EIS) prepared both by FEA for in-house programs and by other Federal agencies for their proposed energy-related actions. EIS's on other FEA programs are prepared under this program in those instances where the proposed Federal action does not fall within any specific program area.

ENERGY CONSERVATION

EC&E conducts a number of conservation programs designed to achieve specific energy objectives in each of the five targets identified: the residential/commercial, industrial, and transportation sectors, utilities, and the Federal Government. EC&E conducts several cross-sector programs to assist State and local efforts. In addition, EC&E provides marketing and educational support to all sector-specific energy conservation programs and develops educational programs for citizens and schools. Activities associated with these energy conservation programs constitute most of EC&E's efforts. Exhibit 2 summarizes the major programs.

Residential/Commercial Sector-

ECGE's efforts in the residential/commercial sector focus on buildings and consumer products. Under one buildings program, Project Conserve, ECGE is helping homeowners, on a pilot basis, to determine which conservation measures (e.g., installation of insulation, storm windows, and storm doors) are cost-effective investments for their homes. The Lighting and Thermal Operations program provides guidelines for lighting, heating and cooling commercial, public, and industrial buildings through publications and seminars

Exhibit 2 Summary of Conservation Programs

PRO	GRAM	DATE STARTED	PURPOSE		
Resi	idential/Commercial				
1.	Project conserve	Feb. 1975	To encourage homeowners, on a pilot basis, to improve voluntarily the thermal efficiency of their homes by providing calculations of home improvement costs and energy savings for each home according to responses to questionnaires.		
2	Lighting & thermal operations	Nov. 1974	To reduce the energy consumed for lighting, heating, and cooling in commercial builtings through voluntary implementation of guidelines.		
3.	Architectural program	Jan. 1976	To bring energy conservation and efficiency concerns into the mainstream of architectural practice and education.		
4.	Public schools energy conservation service	Aug. 1974	To improve the energy efficiency of school buildings.		
5.	Building energy conservation standards*		To encourage State and local governments to incorporate voluntarily into their building codes model energy efficiency standards.		
6.	Low-income weatherization*		To purchase insulation and other materials for the homes of low-income persons, particularly the low-income elderly and handicapped.		
	Residential retrofit tax credit*		To encourage people to retrofit homes with insulation and make other modification by providing a 30 percent investment tax credit for three years.		
8.	Consumer product energy efficiency	Apr. 1973	To improve the energy efficiency of major consumer products (e.g., refrigerators) and label products. Also to educate the public about lifecycle costing.		
nds	ustrial				
9.	Voluntary industrial energy conservation	1974	To encourage greater energy efficiency in American industry, especially the 10 most energy-intensive industries, by identifying conservation potential, removing barriers, determining savings goals, obtaining data, and identifying actions.		
	Technical transfer	1974	To disseminate information on industrial energy conservation potential and technology.		
1.	EPCA: Identification/ ranking, target setting, reporting requirements	Dec. 1975	To assure implementation of specific EPCA requirements concerning industrial programs.		
12	Analysis and evaluation	1973	To analyze and evaluate technical and operational energy conservation options, opportunities, and policies.		
3.	Waste oil recovery and utilization	Jun. 1975	To promote the recovery and re-use of waste oil.		
Fran	nsportation				
4.	New car fuel economy and labeling	Mar. 1975	To educate the public on automobile efficiency and assist EPA and DOT in mandatory fuel economy standards and labeling programs.		
5.	Vanpool	Jan. 1976	To promote employer-sponsored vanpools and encourage the use of vanpools and carpools.		
6.	CAB load factor	Jan. 1976	To reduce energy usage for intercity passenger transportation by increasing the per- centage of seats occupied on aircraft based on passenger miles traveled.		
7.	Voluntary fuel economy for trucks and buses	Oct. 1975	To encourage truck and bus manufacturers voluntarily to improve fuel economy.		
Jtil	ities	2007			
8.	Utilities conservation action now (UCAN)	Aug. 1975	To encourage voluntary participation of gas and efectric utilities, State regulatory agencies, energy offices, and public interest groups in achieving greater energy efficiency.		
19.	Gas utilities demonstration projects	Jan. 1976	To identify methods of increasing the end-use efficiency of natural gas and to remove institutional barriers to retail gas rate reform.		
20.	Electric utility demonstration projects	Oct. 1974	To identify methods of increasing the overall efficiency of generation, transmission, and use of electricity and to remove barriers to adoption of rate reform and load management practices.		
21.	Federal intervention in State regulatory hearings	Apr. 1975	To encourage adoption of time varying pricing, flatteried energy charges, load manament practices, and increased conservation activities by major utilities.		
Fed	eral Government				
-	Federal energy management program (FEMP)	Jun. 1973	To implement a plan for energy conservation with respect to buildings owned or lessed by the Executive Branch and to plan for new FEMP authorities in EPCA.		
Cro	H-Sector				
23.	State/Federal energy conservation	Feb. 1975	To encourage States voluntarily to develop and implement plans to conserve energy		
24.	State energy conservation	Jan. 1976	To assist States to develop and implement plans by providing technical assistance and funding.		
25.	Energy conservation advertising	1974	To promote public action to conserve energy and change behavior through develop- ment of energy conservation awareness and knowledge.		
20	Energy conservation	1975	To provide information to the public on energy problems, alternative solutions, and actions to implement solutions.		

for building owners and managers. Other programs directed at the residential/commercial sector seek to (1) bring energy-conscious design into the mainstream of architectural practice and education, (2) improve the energy efficiency of school buildings, and (3) encourage State and local governments to include energy-efficiency standards in local building codes and provide training workshops for building inspectors and building code officials. In addition to its building programs, EC&E is implementing an appliance energy-efficiency program, as mandated by the Energy Policy Conservation Act (EPCA).

Planning is under way for several conservation programs in the residential/commercial sector, in anticipation of the enactment of legislation. These include programs to purchase weatherproofing materials for the homes of low-income persons, fund demonstration projects and State and local efforts to incorporate energy conservation standards into building codes, and provide tax credits to homeowners who install insulation and make other energy-conserving modifications.

-Industrial Sector-

EC&E's major industrial program has been the Voluntary Industrial Energy Conservation Program. It has resulted in the establishment of voluntary conservation programs in the following industries: aluminum, baking, cement, chemicals, copper, glass, meat packing, paper, petroleum refining, and steel. These programs include energy-efficiency goals and a method of reporting progress toward them, generally via a trade association. A nationwide seminar/workshop program in these and other industries will reach even greater numbers of companies, obtaining their commitment toward energy conservation and providing them with assistance in implementing programs.

EC&E carries out an active program of analysis and evaluation of operational and technical conservation options and opportunities; and develops and disseminates this information to industry via publications, technical workshops/seminars, and other means. Technology transfer includes industry-specific efforts (e.g., food service guidebook, cement study and seminars, guidebooks for different sectors of agricultural production in cooperation with USDA, pilot energy audits), equipment/process-specific efforts (e.g., case histories, program guide for industry and commerce). In the area of waste oil, EC&E has initiated efforts that are broader than the provisions of EPCA relating to the treatment and use of re-refined oil.

EC&E also implements the sections of EPCA relating to the identification/ranking of major energy-consuming industries (according to two-digit manufacturing SIC codes) and companies, setting energy efficiency targets for at least the 10 most energy-consumptive industries, and establishing a reporting process—both from industry to FEA and from FEA to the President and Congress.

Transportation Sector-

EC&E conducts four major transportation programs, as shown in Exhibit 2. In the New Car Fuel Economy and Labeling Program, EC&E publishes and distributes pamphlets containing data on the fuel economy of each model year's automobiles, pursuant to provisions in EPCA. Prior to the enactment of EPCA, EC&E encouraged manufacturers to improve fuel efficiency and label voluntarily.

EC&E is also providing truck and bus manufacturers and operators with information on technical improvements and operating practices that would increase fuel efficiency. Through vanpool demonstration projects, EC&E encourages employers to sponsor vanpool and carpool arrangements for employees. In addition, EC&E is advising the Civil Aeronautics Board (CAB) in analyzing and revising its policies on rates, routes, scheduling, and inflight and ground procedures to increase the energy efficiency of aircraft operations.

-Utilities-

Four programs are aimed at utilities. Under the Utilities Conservation Action Now (UCAN) program, EC&E assists gas and electric utilities, State regulatory agencies, energy offices, and public interest groups in developing and implementing action plans to conserve energy and improve end-use efficiency. Under a second program, EC&E is funding projects to demonstrate the use of different types of rate structures and load management practices in investor- and publicly-owned electric utilities. In a third program, EC&E is conducting a series of demonstration projects to identify methods for increasing the end-use efficiency of natural gas and to remove institutional and informational barriers to retail gas rate reform. The fourth program involves EC&E's participation (upon invitation) in State regulatory hearings to articulate national energy policy as it relates to utilities. EC&E testimony advocates time-varying rates based on marginal costs, promotes load management techniques consistent with marginal cost pricing, and encourages increased conservation practices.

Federal Government-

Under the Federal Energy Management Program (FEMP), ECGE assists Executive Branch agencies in improving energy efficiency in their facilities and operations. ECGE's actions include assistance in implementing design standards for new Federal buildings; retrofitting existing Federal buildings with insulation, systems controls, storm windows, solar water heating, and other energy-saving equipment or techniques; procuring fuel-efficient cars and trucks for Federal fleets; implementing life-cycle costing techniques in procurement of energy-intensive products by Federal agencies; and educating Federal employees.

Cross-Sector Programs

Several of EC&E's programs promote energy conservation in more than one sector. The State Energy Conservation Program mandated by EPCA authorizes ECSE to provide technical and financial assistance to States to assess the feasibility of establishing a State energy conservation goal and to develop, implement, and modify a plan to achieve it. To be eligible for EPCA funds, this plan must include mandatory lighting efficiency standards for public buildings; programs to promote carpools, vanpools, and public transportation; mandatory energy efficiency standards to govern procurement practices; mandatory thermal efficiency standards and insulation requirements for new and renovated buildings; and a law permitting right turns at red lights after stopping. EC&E will also continue its State/Federal Energy Conservation Program to provide technical assistance to States that do not wish to participate in the State energy conservation program but do conduct programs to improve energy efficiency.

As part of its marketing and education programs, EC&E conducts monthly marketing and opinion surveys on consumer attitudes about energy use, conservation, and trends in energy consumption patterns. EC&E also develops appropriate promotional and educational materials for use in television and radio public service advertising, poster campaigns, and citizen and in-school education.

PROGRAM JUSTIFICATION

The major thrust of EC&E's energy conservation programs is to promote and accelerate private and public investment in sound energy conservation measures. The high and still rising prices of new energy supplies in the United States have made increased energy efficiency a sound investment for virtually every sector of our economy. Yet, for a number of reasons, energy consumers of all types have been slow to adopt more efficient materials and practices. By causing the adoption of energy conservation measures or by speeding the rate by which practices that might occur gradually as a result of market forces are implemented, EC&E is effectively increasing the total amount and value of resulting benefits. For, if Government action induces or accelerates the adoption of certain energy conservation measures, thereby obtaining benefits sooner, the result is a net increase in benefits.

Exhibit 3 presents the projected primary energy savings associated with EC&E's existing and proposed major programs from 1974, the year of EC&E's establishment, through 1985. The equivalent of more than 9 billion barrels of oil will be saved during this period. As indicated in Exhibit 4, approximately 80 percent, or 7 billion barrels, of this amount would have been imported. The passage of EPCA substantially increased expected annual energy savings in 1977 to a total of more than one million barrels per day (assuming adequate funding and program support). To date, approximately 200 million barrels of oil have been saved as a direct result of EC&E's activities.

Exhibit 3

Primary Energy Savings by Major Existing and Proposed Energy Conservation Programs^a

	^b Equivalent barrels of oil per day x 10 ³							Cumulative					
	1974	775	'76	'77	'78	'79	'80	'81	'82	'83	'84	'85	Total (10° bb))
Residential & Commercial Sectors													
Building energy conservation standards	20	100	-		1	33	84	136	188	242	206	350	1 485
Weatherization assistance	-	-	- 6	15	25	25	25	25	25	25	25	25	80
Residential retrofit tax credit	-			130	130	130	130	130	130	130	130	130	427
Project conserve	1,33	neg.	neg.	28	42	56	70	70	70	70	70	70	199
Lighting & thermal operations	13.5	16	28	40	67	93	100	100	100	100	100	100	308
Consumer product energy conservation	-	-	10	20	35	70	185	300	415	530	645	760	1084
Subtotal	1 -	16	43	233	299	407	594	781	928	1097	1266	1435	2584
Industrial Sector						-			-				1 2001
Industrial energy efficiency ^d	HE.	. 10	30	330	375	404	426	397	367	336	309	200	
Waste oil utilization			33	10	16	23	30	31	32	338	34	280	1192
Subtotal		10	30	340	391	427	456	428	399	371	343	315	1281
Transportation Sector*		100		-	-	-		1120	- Orro	311	343	315	1 1281
Fuel economy performance standards !		6	37	-		To Section	1000	170000					W
Fuel economy program for trucks & buses		0	37	68	100	125	150	320	490	660	830	1000	1382
Vanponi	10	172	2	125	35	50	65	77	89	101	113	125	248
CAB load factor	9	6	2	. 8	20	32	45	58	70	83	95	110	191
Subtotal		6	746	-	40	51	68	74	85	97	109	120	233
	-	0	146	94	195	258	323	529	734	941	1147	1355	2054
Utilities ^s	-	-	-	-	-	14	-	100	-	-	-	-	1 2
intergovernmental													
State energy conservation programs	NE.	100	12	272	370	560	750	770	790	610	830	000	1
ederal energy conservation program*	225	266	256	250	255	262	269	276	283	290		850	2191
Subtotal	225	266	256	522	625	822	1019	1046	1073		297	305	1180
Total					94.0	OZZ	1019	1046	10/3	1100	1127	1155	3371
Otal	225	298	375	1189	1510	1914	2392	2764	3134	3509	3883	4260	1 9290

Assuming adequate funding and program subport. Marketing, education, and other EC&E programs are omitted to avoid double counting.

1 bit | 5.5 x 10 Bits;

1 req. - negligible (approximately 7 barrels per day oil agoinvalent)

1 includes swings from voluntary and industrial work shop programs. Assumed is that market forces would have induced energy savings by 1980 were no Companion action taken. Thus, energy savings resulting from EC&E efforts are shown as declining after 1980.

1 Excludes saving absociated with for mph speed first.

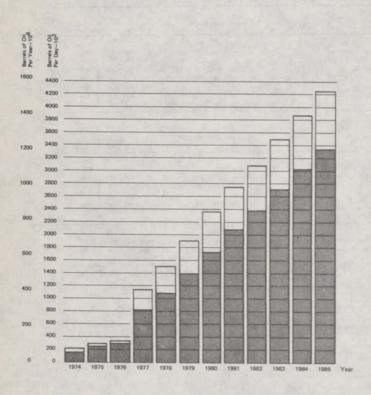
1 The primary of the obstrately program.

2 The primary of the savings associated with utilities programs have not yet been determined. However, the import reductions associated with the officers savings from EC&E.

3 The primary of the control o

Exhibit 4
Annual Primary Energy Savings and Import Reductions

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Import Reductions Energy savings mean dollar savings. Exhibit 5 delineates the dollar savings associated with EC&E conservation programs—a value in 1975 dollars of nearly \$66 billion for the period of 1974 through 1985. A \$13 per barrel world petroleum price and a 10 percent discount rate, to account for the time value of money, have been used. Since the figures in the exhibit represent only the dollar value of energy saved, they underestimate total dollar savings. For example, EC&E's energy conservation programs directed toward utilities alone are expected to reduce utilities' required capital outlays by \$48 billion by 1985.

Discounted Dollar Savings by Sector
Associated with Existing and Proposed Federal Programs^a

Sectorb	1974	175	'76	'77	78	779	'80	'81	*82	'83	'84	'85	Total
Residential/Commercial.	0	75.9	185.5	912.7	1065.9	1319.0	1750.1	2038.3	2250.5	2428.3	2547.6	2625.2	17,200.1
Industry	0	47.4	129.4	1333.3	1393.9	1383.9	1343.5	1146.4	971.5	821.2	690.2	576.3	9,837.0
Transportation	-0	28.5	190,4	368.6	695.2	836.1	951.6	1416.9	1787.2	2083.0	2308.2	2478.8	13,152.6
Utilities	-	-		2	120		1941				_	-	-
Intergovernmental	1174,4	1262.2	1104.3	2047.0	2228.1	2664.0	3002.2	2801.6	2612.7	2434.9	2267.9	2113.0	25,712.3
Total	1174.4	1414.0	1617.6	4662.6	5383.1	6203.0	7047.4	7403.2	7631.0	7767.4	7813.9	7793.3	65,910.9

" Using \$13/barrel and 10% discount rate—all figures in 1975 dollars. Dollar value of stream of energy saved only in Refer to Exhibit 3 for primary energy sevings by sectors.

The cost to the Government of initiating these energy and dollar savings is composed of two elements. First, the funds directly required by EC&E to carry out its mission, including any grants made to the States. Second, the loss of Government revenues associated with certain proposed programs (e.g., the investment tax credit for residential retrofit). Federal funds actually appropriated to EC&E have been: \$1,963,000 in FY 1974, \$17,906,000 in FY 1975, and \$46,761,000 to date in FY 1976. The energy savings shown in Exhibit 3 are based on future funding levels assumed adequate to carry out ongoing and legislated programs effectively. The weatherization and residential retrofit programs pending legislation are not included in the calculation; however, energy savings have been estimated. A simple comparison of actual 1974 and 1975 energy savings (200 million barrels of oil valued at \$2.6 billion for the two-year period) with Government expenditures (approximately \$20 million) indicates the cost-effectiveness of EC&E programs.

A measure of the maximum cost that is economically justifiable to the private sector is the net present value of the 1974 to 1985 savings stream, i.e., \$66 billion using a \$13 per barrel and 10 percent discount rate. This figure of \$66 billion corresponds to the net private benefits. If all the external costs associated with the production, transportation (transmission), delivery, and use of various forms of energy were included in the energy prices, the socially optimal rate of investment in energy conservation would be significantly higher.

B. HIGHLIGHTS

This section describes the current status of energy conservation and environmental programs, including the most recent indicators of energy conservation and consumption, highlights of major program activities which occurred between October 1975 and February 1976, and a list of EC&E publications.

ENERGY SAVINGS INDICATORS

ECGE will present three types of energy savings indicators and data quarterly. First, year-to-date energy consumption will be compared with the corresponding period for the previous two years and with projected energy consumption based on the 1964 to 1973 trend. Second, a set of energy conservation and consumption indicators will be presented and updated quarterly. Over time, these two types of data will provide a profile of the impact of conservation efforts in the United States. Third, specific energy savings data based on measured tests and surveys associated with specific programs will be presented wherever possible. Because of the time factor associated with collecting, reporting, and interpreting data, the energy savings figures provided in this section may lag behind the current report quarter. However, ECGE is continuously improving its energy savings data base.

Exhibit 6 compares year-to-date consumption with past and projected consumption for the major end-use consuming sectors and

Exhibit 6
Energy Consumption

	ugh Novembe	- % change	vs. Projected	
1975	vs. 1974	vs. 1973		
Total Energy	-2.8	-5.2	-12.4	
Buildings	+2.2	0	-9.1	
Transportation	+0.7	-3.3	-12.1	
Industry	-9.4	-10.9	-16.8	
Gasoline	+2.0	-0.7	-9.5	
Total petroleum	-2.1	-6.6	-15.3	
Total petroleum imports	-0.7	-4.5	NAD	
Electrical output	+2.0	+2.0	-11.4	

a Projected consumption is based on the 1964 to 1973 trend.

DNA-not available

1973, respectively.

gasoline, oil and electrical use. For example, for the January through November period, total energy consumption in 1975 was 2.8

percent and 5.2 percent below that for the same period in 1974 and

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Exhibit 7 presents 14 energy conservation/consumption indicators. (The actual dates used for comparison vary somewhat among

Exhibit 7 **Energy Conservation/Consumption Indicators**

	% change in average						
Indicators	1975/ year to date	vs. 1974	vs. 1973	vs. Trend Growth 1			
Residential/Commercial Sector		A STATE OF THE REAL PROPERTY.					
Electrical usage by commercial sector	October	+6.6	+5.0	-10.9			
2. Electricity usage per household	October	+4.1	+0.8	-11.2			
3. Heating degree-days ²	November	-2.7	+3.3	NAP			
4. Household energy prices ³	December	+5.6	+18.7	NA			
5. Natural gas usage per household	September	45.1	-1.5	NA			
6. Per capita Btu usage	November	-3.6	-6.6	-12.4			
Industrial Sector							
7. Energy inputs per unit of industrial output 4	October	+0.3	-1.5	+1.2			
8. Industrial production	October	-10.1	-10.0	-18.3			
Transportation Sector							
9. Airline load factor	December	-2.0	+3.0	NAP			
Actual percentage	53.7	54.9	52.1	NAP			
10. Gasoline consumption per capita	December	+1.0	-1.8	-8.5			
11. New car sales (average weight)	1975 models	+1.7	+3.0	NA			
Actual weight	4,088 lbs.	4,018 lbs.	3,968 lbs.	NA.			
12. New car sales (miles per gallon)	1975 models	+12.2	NA.	NA			
Actual miles per gallon	15.6 mpg	13.9 mpg	NA	NA			
13. Regular gasoline prices (in constant \$ per gallon)	December	-2.8	+22.7	NA			
Actual price (in current \$)	56.1d	52.8∉	39.0∉	NA			
Utilities							
14. Utilities peak demand growth rate	October	+2.3	+3.1	-11.3			

NA-not available NAP-not applicable

Based on the trends for 1964-1973.

Weighted according to annual consumption of distillate heating oil per state.

³ Calculated as the composite retail price increases of electricity, natural gas, fuel oil, and coal, excluding gasoline, in constant dollars.

⁴Calculated as total energy Btu's consumed in the industrial sector divided by the Industrial Production Index.

indicators because the data available did not permit use of the same time periods for all indicators.) The table shows, for example, that for January through November 1975, per capita Btu consumption was 3.6 percent and 6.6 percent below that in the same period of 1974 and 1973, respectively, and 12.4 percent below that projected for 1975 based on trends from 1964 to 1973. Although some measures indicate increased consumption in 1975 compared to 1974 (e.g., natural gas usage per household, electricity usage per household), most indicate decreased consumption in 1975 compared to the projected consumption for the same period (e.g., per capita Btu usage, electricity usage per household, gasoline consumption per capita). While energy conservation is, in part, the result of more efficient energy use, other factors also affect the level of consumption. For example, warmer weather, less economic activity and higher prices decrease energy use. Data pertaining to some of these factors (e.g., gasoline prices, heating degree-days, and industrial production) are also provided in Exhibit 7.

HIGHLIGHTS OF CURRENT PROGRAM ACTIVITIES

Highlights of the major energy conservation and environmental program activities conducted by EC&E from October 1975 through February 1976 are presented in this section. Many of the activities are ongoing and involve planning and preparation for program actions. During this report period, much of EC&E's effort has been directed at planning and preparing for the implementation of EPCA, especially for the consumer product, industrial, Federal energy management, and State programs. The descriptions that follow highlight the significant and major activities of these programs.

Residential/Commercial Sector-

EC&E tested the administrative aspects of Project Conserve, in Minneapolis-St. Paul, Indianapolis, and Louisville. EC&E distributed packages to Governors encouraging them to incorporate Project Conserve into State conservation programs; in response, 24 States submitted proposals. EC&E selected New Mexico and Massachusetts for the distribution of questionnaires (see Attachment 1)* to approxi-

^{*} Limited numbers of this report will include this questionnaire as an attachment.

mately one million homeowners. The following States were selected for distribution of a self-help manual to be used by homeowners for identifying economical energy conservation actions: Connecticut, Illinois, Maryland, Nebraska, New York, Ohio, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, and Utah.

EC&E continued nation-wide visits and seminars for building owners and managers as part of the Lighting and Thermal Operations Program. EC&E also began training teachers to lead seminars on energy considerations in building designs for practicing architects and students at architectural schools. A design competition was opened as well for students in 89 professional schools of architecture. In the Public Schools Energy Conservation Service Program, engineering studies of Minnesota schools and a demonstration project in that state were completed, and a two-volume Energy Conservation Handbook for Colleges and Universities was prepared.

-Industrial Sector-

EC&E published the second progress report of the gains made by the 10 industries having industry-wide voluntary energy conservation programs. Exhibit 8 summarizes the progress the 10 industries have made in improving energy efficiency and lists the industry-wide conservation goal for 1980. While the table indicates general progress toward the energy efficiency goals, it also shows the adverse impact of economic downturns and low production levels on energy efficiency measured in terms of energy (Btu) per unit of production. EC&E staff visited selected companies to implement parts of the company-specific phase of the voluntary program. EC&E's major technology transfer efforts included seminars for the cement industry, pilot energy audits, and the publication and distribution of the Guide to Energy Conservation for Food Service and the Energy Conservation Program Guide for Industry and Commerce Supplement. Staff efforts continued on activities in such areas as: boiler efficiency, industrial insulation, waste heat, waste oil, case histories, energy in agricultural production, the energy conservation seminar/workshop program, policy analysis and input to PIES, and—as indicated previouslyimplementation of specific EPCA industrial-related provisions.

Exhibit 8 Improvements in Energy Efficiency for the Ten Most Energy-Intensive Industries

Industry	Association ^a	% improvement through Dec. 1974	from 1974 pr through June 1975	ogram inception 1980 Goal
Aluminum	Aluminum Association	5.8	6.5	10
Baking	American Bakers Association	Lan 2 To	2.7	15
	Biscuit and Cracker Manufacturers Association	-	2	10
Cement	Portland Cement Association	1.6		10
Chemicals	Manufacturing Chemists Association	7.5	5.0	15
Copper	American Mining Congress	-	JUNE MILE	-27 ^b
	Copper and Brass Fabricators	_		8
Glass	Glass Container Manufacturers Institute	.4	.4	5
	Flat Glass Manufacturers	_	5.0	15
	Pressed and Blown Glass Manufacturers	10.5		12
Meat packing	American Meat Institute and National Independent Meat Packers Association	3122	6.9	10
Paper	American Paper Institute		2.3	10
Petroleum refining	American Petroleum Institute	7.8	8.9	15
Steel	American Iron and Steel Institute	2.7	-2.1°	10

⁸ Industries report progress through these trade associations.
^bExpected decrease in efficiency is caused by increase in energy usage per unit production as a result of decreasing one grade. Without conservation efforts, a greater decrease in efficiency could be expected.

Decrease in energy efficiency per unit of output by 2.1 percent.

-Transportation Sector-

Major events included the distribution of the 1976 Gas Mileage Guide for New Car Buyers, the revision of the guide to update and broaden the information to include more models (see Attachment 2),* the start of a study to develop and test employer-targeted marketing strategies for fostering employer-sponsored vanpool programs, and intervention in Civil Aeronautics Board hearings on rate policy and fare determinations. Hearings were also held on the Voluntary Fuel Economy for Trucks and Buses Program.

-Utilities

Ten utilities Conservation Action Now (UCAN) regional workshops were held at which participants exchanged information and were

^{*} Limited numbers of this report will include this guide as an attachment.

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	State	Utilities	Regulatory Commissions	Otherb	
VALSHEY.	Alabama	2	F- 1 540	MA SELL	
	Arizona	2		1	
	Arkansas	1			
	California	5	1	2	
	Colorado		1		
	Connecticut	4	1	1	
	Delaware	1			
	Florida	1			
	Georgia	1			
	Idaho	1		2	
	Illinois	2			
	Indiana	3			
	Iowa	2		1	
	Kansas	2			
	' Louisiana	4		1	
	Maine	1			
	Maryland	1		10	
	Massachusetts	7			
	Michigan	5			
	Minnesota	1			
	Missouri	2		1	
	Nebraska	4			
	New Hampshire	1	1	1°	
	New Jersey	3			
	New Mexico	1			
	New York	8	1		
	North Carolina	1			
	North Dakota	1			
	Ohio	5			
	Oklahoma	3		1	
	Oregon	2			
	Pennsylvania	7	1	6d	
	Rhode Island	1	1		
	South Dakota			2e	
	Texas	7	3	1	
	Vermont	2	1		
	Virginia		1		
	Washington	2			
	West Virginia	- 1			
	Total	97	12	21	

<sup>Includes organizations that have indicated their desire to participate by submitting a draft action plan or a letter of intent by March 1976.
Includes State energy and other offices, development commissions, and public interest groups.
Includes State energy offices.
Includes Governor's Office and State Department of Community Affairs.
Includes State Economic Opportunity Office.</sup>

instructed on how to develop action plans. Approximately 100 draft plans have been received. Exhibit 9 summarizes the participation in UCAN. Electric utility demonstration projects continued in Arizona, Arkansas, Connecticut, Michigan, New Jersey, Ohio, Vermont, Wisconsin, New York, and California. EC&E participated in State regulatory hearings in New York, Colorado, Minnesota, Virginia, Wisconsin, North Carolina, New Hampshire, and Texas. Partially as a result of EC&E testimony and consistent with EC&E recommendations, regulatory commissions in New York and North Carolina have recently ordered their utilities to begin implementing time-varying pricing.

-Federal Government-

Events focused on continuing FEA involvement with FEMP and on some planning for new FEMP authorities in EPCA. Planning included the preparation of a draft Executive Order delegating responsibility to FEA for incorporating EPCA requirements into FEMP, and drafting a multi-year action plan. FEMP accounts for approximately 86 percent of the energy savings (see Exhibit 3) and 94 percent of the dollar savings (see Exhibit 5) associated with EC&E programs through 1975.

-Cross-Sector Programs-

As part of the State programs, EC&E held four workshops with 47 State Energy Office representatives to explain the use of data reporting forms and to obtain feedback on any problems. Copies of a two-volume draft source book were distributed to States. Under EPCA's requirements, EC&E also published guidelines for State energy conservation feasibility reports and determined a formula for funding State planning efforts.

As part of marketing and education programs, EC&E conducted monthly marketing and opinion surveys and developed the Energy Activity Guide (see Attachment 3)* for demonstration education projects in six park systems. Technical papers for a manual for a citizen training program on energy conservation were developed and the first of 10 regional citizen conservation workshops was held.

^{*} Limited numbers of this report will include this guide as an attachment.

Environmental Programs

EC&E, as part of its environmental laws and regulations program, completed and distributed to Congress two major studies on the significant deterioration of air quality in order to apprise Congress of the impact of this proposed Clean Air Act requirement on the electric utility industry. Comments were also provided on the draft National Commission Water Quality Report and on EPA's water quality criteria, and a detailed technical evaluation of the energy impacts of the proposed EPA State Implementation Plan for Ohio was initiated.

In the energy resource development program, EC&E continued to assess important environmental/energy resource issues. Comments were prepared on the Department of the Interior's (DOI) coal mining operating regulations and on their "diligence requirements" for coal leasing. Several tasks related to major OCS and Alaskan natural gas issues were completed, and an environmental assessment of the Blue Ridge project prepared. In addition, several letters of comment were prepared on other agencies' EISs relating to major energy programs for Arctic natural gas, Kapairowits, and wild and scenic rivers.

C. PUBLICATIONS

As part of its effort, EC&E publishes manuals, handbooks, reports, fact sheets, and other materials of interest to business, industry, Government personnel, and the general public. Some of these documents have been published as part of EC&E's Conservation Paper Series. These publications as well as other materials are listed below, along with a brief description of the contents, length, number printed, and availability. Publications with GPO numbers are available from the Government Printing Office; those with NTIS numbers are available from the National Technical Information Service of the United States Department of Commerce. Some materials (e.g., fact sheets) are available directly from EC&E program offices. For these publications, the EC&E program office is listed.

Several EC&E documents are currently in the process of being printed. As these materials become available for distribution, they will be added to the list of publications in future quarterly reports.

CONSERVATION

- la* Energy Management Case Histories (15 pages)
 - GPO 041-018-00062-3
 - NTIS PB-244 908/AS

Discusses how four companies organized to achieve energy conservation, how they implemented their energy savings projects, and what the results were. 2,000 copies printed.

- 1b Energy Management Case Histories. November 1975. (24 pages) NTIS PB-246 763/AS
 Presents case histories of four additional companies (see Conservation Paper la). 20,000 copies printed.
- 2 Federal Energy Management Program (FEMP)

 1st Quarter Report 1975 (8 pages)

 NTIS PB-241 856/AS

 Summarizes the program's progress. 6,000 copies printed.

^{*} Conservation Paper No.

- 3 <u>Lighting and Thermal Operations Guidelines</u> (10 pages)

 Available from the Office of Buildings Programs

 Contains guidelines which represent desirable targets for illumination levels, lighting efficiency, and operation of heating and cooling systems. 101,500 copies printed.
- 4 <u>Lighting and Thermal Operations</u>: Building Energy Reports Case Studies (20 pages)
 - Available from the Office of Buildings Programs
 For 19 Federal office buildings presents energy consumption
 before and after implementation of energy conservation programs
 that included recommendations for illumination, thermostat
 settings, building occupancy, and fan operation. 168,200 copies
 printed.
- 5 Project Conserve Final Report: A Pilot Project in Homeowner Energy Conservation (84 pages)
 - Available from the Office of Buildings Programs
 Presents results of testing utilization, reliability, effectiveness, and cost of the project. 2,000 copies printed.
- 6 Training Manual for Youth Programs
 not yet in print
- 7 Study of the Impact of Reduced Store Operating Hours on Sales, Employment, Economic Concentration, and Energy Consumption (238 pages)

(238 pages) - NTIS PB-243 579/AS

Estimates energy savings resulting from regulating store hours, provides scenarios of regulatory schemes, analysis of likely economic changes, and statements of least disruptive hours of closing. 100 copies printed.

8 The Potential for Energy Conservation in Nine Selected Industries: The Data Base (Summary Volume) (505 pages)
- NTIS PB-243 611/AS

Presents basic data on energy consumption in all nine industries, including descriptions of the processing sequences for each, data sources, materials consumed, and the energy required. Each of nine volumes discusses one industry in depth. 500 copies printed.

- 9 Vol. 1: <u>Selected Plastics</u> (144 pages)
 GPO 041-018-00064-0
 NTIS PB-243 612/AS
 600 copies printed.
- 10 Vol. 2: Petroleum Refining (382 pages)
 GPO 041-018-00065-8
 NTIS PB-243 6]3/AS
 1,100 copies printed.
- 11 Vol. 3: <u>Cement</u> (122 pages)
 GPO 041-018-00068-1
 NTIS PB-243 614/AS
 600 copies printed.
- 12 Vol. 4: Copper (118 pages)
 GPO 041-018-00061-5
 NTIS PB-243 615/AS
 600 copies printed.
- 13 Vol. 5: Aluminum (122 pages)
 GPO 041-018-00067-4
 NTIS PB-243-616/AS
 600 copies printed.
- 14 Vol. 6: <u>Steel</u> (139 pages) - GPO 041-018-00068-2 - NTIS PB-243 617/AS 600 copies printed.
- 15 Vol. 7: Glass (126 pages)
 GPO 041-018-00069-1
 NTIS PB-243-618/AS
 600 copies printed.
- 16 Vol. 8: <u>Selected Paper Products</u> (155 pages)
 GPO 041-018-00070-4
 NTIS PB-243 619/AS
 600 copies printed.
- 17 Vol. 9: Styrene Butadiene Rubber (133 pages)
 GPO 041-018-00071-2
 NTIS PB-243 620/AS
 600 copies printed.
 Set of 10 Volumes
 NTIS PB-243-610

- 18 Lighting and Thermal Operations: Energy Conservation Principles
 Applied to Office Lighting (288 pages)
 - NTIS PB-244 154/AS

Reviews the literature and findings upon which past lighting designs have been based, and recommends changes. 5,000 copies printed.

- 19 Second Conference on Utility Load Management - NTIS PB-244 285/AS 100 copies printed.
- 20 <u>Guidelines for Saving Energy in Existing Buildings: Building</u>
 <u>Owners and Operators Manual</u> ECM 1 (299 pages)
 GPO 041-018-000-79-8

 Describes options and minor modifications to buildings, mechanical and electrical systems that can be implemented immediately

with little if any investment cost. 250 copies printed.

- 21 Guidelines for Saving Energy in Existing Buildings: Engineers,
 Architects, and Operators Manual ECM 2 (448 pages)
 GPO 041-018-000-80-1
 Presents additional and more complex ways to lower operating
 costs than those in ECM 1, involving investment costs that can be
 recovered within 10 years. 250 copies printed.
- 22 Federal Energy Management Program (FEMP)
 2nd Quarter Report 1975 (8 pages)
 NTIS PB 245 183/AS
 Reports on energy savings achieved in the Federal Government.
 4,000 copies printed.
- 23 Retrofitting Homes for Energy Conservation, a Business Guide
 (64 pages)
 Out of print; second printing in progress
 Discusses the emerging demand, markets, unique aspects of the
 retrofitting business, management of retrofitting work crews,
 development of retrofitting packages, and methods of calculating
 needs and savings. 6,600 copies printed (first printing).
- 24 <u>Utility Load Management Conference Proceedings</u> (113 pages) - NTIS PB-244 576/AS Seventeen papers present key issues in rate reform, enabling technology, and load management. 500 copies printed.

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- 25 Federal Energy Conservation Briefs (24 pages)
 Available from FEMP Office
 Folder containing 24 one-page briefs summarizing actions taken at various Federal buildings, the situation before and after the action, and the resulting energy savings. 1,350 copies printed.
- 26 Energy Conservation Potential in the Cement Industry (309 pages)
 NTIS PB-245 159/AS
 Presents historic and projected energy requirements for U.S.
 cement industry, discusses the processes and new energy saving
 technology, and compares U.S. energy efficiency with that of
 Japan and Europe. 400 copies printed.
- 27 Potential for Energy Conservation in the Steel Industry
 (351 pages)
 NTIS PB-244 097/AS
 Examines both existing and new technologies in steel manufacturing that offer significant opportunities for energy conservation in the next five years and notes problems which might limit energy savings by 1980. 5,500 copies printed.
- 28 Project Retrotech: Teacher's Kit for Course of Home Weatherization (148 pages)

 - Available from the Office of Weatherization
 Set of four booklets containing materials for an instructor of a course in the basic techniques of retrofitting existing housing.
 60,000 kits printed.
- 28a Teacher's Guide to Home Weatherization. 50,000 copies printed.
- 28b Home Weatherization Job Book. 270,000 copies printed.
- 28c Home Weatherization Manual. 165,000 copies printed.
- 28d Home Weatherization Charts. 58,000 copies printed.
- Digest) (22 pages)
 GPO 041-018-00095-0
 Summarizes a study of the cement industry, briefly discussing energy use in the industry's processes, energy conservation technology, investment costs and savings, and prospects for applying energy conservation technology. 5,000 copies printed.

Energy Conservation in the Cement Industry (Technology Transfer

- 30 Federal Energy Management Program (FEMP): 3rd Quarter Report
 FY 1975 (8 pages)
 NTIS PB-246 314/AS
 Reports on energy savings achieved in the Federal Government.
 4,000 copies printed.
- 31 Pricing Distortions of Petroleum Products (73 pages)
 NTIS PB-246 289/AS
 Examines costs of petroleum products, predicted internal costs, pollution abatement costs, and special treatment of the petroleum industry (tax provisions, policies). 500 copies printed.
- 32 Opportunities and Incentives for Electric Load Management
 (315 pages)
 Available from the Office of Utilities Programs
 Examines causes and effects of poor system load factors, rationalization of rate structures, time-of-day metering and load control, load leveling, and similar issues. 500 copies printed.
- Comparison of Energy Consumption between West Germany and the United States—A Summary (13 pages)

 NTIS PB-245 652/AS

 Summarizes study which examines and explains the differences in per capita energy consumption between the U.S. and West Germany, and attempts to quantify the factors involved, 2,000 copies printed.
- 34 Energy Conservation Potential of Urban Mass Transit (28 pages)
 Available from the Office of Transportation Programs
 Discusses the future role of mass transit in the U.S., the energy
 conservation potential of increased transit service, and longterm advantages—such as improved mobility, reduced urban congestion and air pollution. 750 copies printed.
- 35 UCAN Manual of Conservation Measures (192 pages)
 Available from Office of Utilities Programs
 Discusses the underlying principle, potential for energy conservation, and specific implementation strategies for twelve measures, which include rate reform, load management and control, energy audit consultation, and recovery of energy from solid waste. 1,700 copies printed.
- 36 FEMP Second Annual Report
 not yet in print



37 Energy in U.S. Agriculture: Compendium of Energy-Related Projects (176 pages)

- Available from Office of Communications and Public Affairs
Presents ongoing or recently completed research projects and
article abstracts related to full requirements and energy conservation practices and technologies. 4,000 copies printed.

FACT SHEETS

Each of the following fact sheets (each about four pages) describes one of the EC&E programs.

- Electric Rate Demonstration Program
 Available from the Office of Utilities Programs
 6,500 copies printed.
- Energy Efficiency Report
 Available from the Office of Industrial Programs 1,500 copies printed.
- The FEA/EPA Fuel Economy Labeling Program
 Available from the Office of Transportation Programs
 12,000 copies printed.
- Federal Intervention in State Regulatory Hearings Available from the Office of Utilities Programs 6,500 copies printed.
- Industrial Energy Conservation Report GPO 898-293
 3,000 copies printed.
- Natural Gas Profile: The Baking Industry
 Available from the Office of Industrial Programs
 2,000 copies printed.
- State/Federal Energy Conservation Program
 Available from the Office of State Programs
 5,500 copies printed.
- Voluntary Fuel Economy Program for Trucks and Buses
 Available from the Office of Transportation Programs
 11,000 copies printed.

- Voluntary Industrial Energy Conservation Program Available from the Office of Industrial Programs 107,500 copies printed.
- 10. Waste Oil Fact Sheet Available from the Office of Industrial Programs 2,375 copies printed.

OTHER MATERIALS

- An Analysis of the Impact on the Electric Utility Industry of Alternative Approaches to Significant Deterioration. (2 Volumes plus Supplements) October 1975. (195 pages) - Available from the Office of Environmental Programs Evaluates the impacts on the electric utility industry of the various approaches, proposed by the EPA, Senate, and House, to preventing significant deterioration of air quality. 1,900 copies printed.
- 2. Assessment of the Impact of Proposed Thermal Effluent Guidelines for the Steam Electric Power Industry. November 1975. (113 pages) - Out of print

Studies the system aspects of utility operation in order to assess the impact of controls imposed on a plant-by-plant basis according to uniform national limitations and the schedule for implementation. 25 copies printed.

- 3. Bituminous Emulsions for Highway Pavements. Prepared by the Transportation Research Board, Washington, D.C. 1975. (80 pages) - Available from the Transportation Research Board, Washington, D.C. Describes current practices in the use of emulsified asphalts, step-by-step procedures to achieve quality construction, and identified research needs. 8,000 copies printed.
- 4. Bumper Stickers - Available from the Office of Marketing and Education Five Bumper Stickers which read: (1) I'm 55 Drive Me; (2) Fast is Fuelish; (3) The Faster You Drive The Richer They Get; (4) Drive 55 Today or Tomorrow You Won't; and (5) Pass Me Now You'll Be Walking Later. 1,200,000 copies printed.

Description of Major Programs

- GPO 898-483

Describes 29 major EC&E programs now underway and planned. 16,250 copies printed.

Electric Utilities, Clean Air Act Amendments and Sulfates July, 1975 (54 pages)

- Available from the Office of Environmental Programs Provides the basis for FEA's proposed Clean Air Act amendments that apply to stationary sources and the use of coal; provides background material on the energy problem, the President's proposed energy program, and FEA's coal conversion and loan management programs. 1,100 copies printed.

7. Energy Conservation Program Guide for Industry and Commerce (EPIC) (212 pages)

- GPO C13.11:115

A handbook for those persons responsible for the use of energy in intermediate and small-sized firms; provides engineering data, procedures for financial analysis, sources of assistance, and other information. 103,200 copies printed.

8. Energy Conservation Program Guide for Industry and Commerce-Supplement 1. Dec., 1975. (9 pages)

- GPO C13.11:115/1

Includes revised explanation of how to implement an energy conservation program, an expanded checklist of energy conservation opportunities, more case histories, and additions and revisions to other sections of the handbook. 30,000 copies printed.

Energy Conservation-Understanding and Activities for Young People (20 pages)

- Available from Office of Communications and Public Affairs Provides curriculum material on energy sources, conservation and use. 250,000 copies printed.

10. Energy Savings Calculator

- GPO 75-0-652-897

Shows homeowners the initial costs of six energy conservation measures (storm windows, heat pumps, etc.) and how long it will take to pay back initial investment, with savings in dollars, kilowatt hours, etc. 25,000 copies printed.

- Environmental Impact Statement on Electric Facilities Construction Incentives Act. (Draft) July, 1975. (22 pages) - Available from the Office of Environmental Impacts Analyzes energy and environmental impacts of proposed legislation providing for the expansion of electric power facilities other than petroleum and natural gas-fueled facilities. 100 copies printed.
- 12. Environmental Impact Statement on the Mandatory Oil Import Fee Program. October, 1975. Available from the Office of Communications and Public Affairs Describes environmental, social and economic impacts that could be expected to result from the oil import fee schedule established in Presidential Proclamation Nos. 3279, 4210, 4341, and 4355. 2,000 copies printed.
- 13. Environmental Impact Statement on the Natural Gas Emergency Standby Act of 1975. November, 1975. (297 pages) - Available from the Office of Environmental Impacts Treats environmental and energy impacts of the proposed Act intended to prevent or ameliorate the social and economic impacts of impending natural gas curtailments. 2,000 copies printed.
- Feasibility of a Single Tall Stack in Power Plant Construction June, 1975 (75 pages) - Out of print Analyzes the use of a simple stack to serve a power plant with multiple boilers as an alternative to multiple tall stacks pollution abatement. 25 copies printed.
- 1976 Gas Mileage Guide for New Car Buyers (1st Ed.). September 1975 (18 pages) - Available from Office of Communications and Public Affairs Pamphlet on U.S. cars and imports provides city, highway, and average fuel economy (mpg) for each car line, engine size, number
- of cylinders and type of transmission. 2,000,000 copies printed. 16. Guide to Energy Conservation for Food Service. October, 1975. (74 pages)
 - GPO 041-018-00085-2

Discusses how to conserve energy in a food service establishment: how energy losses can occur and the potential for savings, how to increase energy efficiency of presently-owned equipment, and how to chart energy consumption. 28,100 copies printed.

- How to Save Money by Insulating Your Home - GPO 75-0-579-320 An easy how-to instruction pamphlet for insulating a home. 400,000 copies printed.
- 18. Light Switch Decals - Available from the Office of Marketing and Education Three decals which read: (1) Hit Me; (2) Hit Switch; and (3) Empty Rooms Love Darkness. 1,000,000 copies printed.
- Low-Income Demographic Data. Nov., 1975. (9 pages) - Available from Office of Low-Income Weatherization Presents demographic data pertinent to the Weatherization Assistance Act of 1975 (H.R. 8650). 1,250 copies printed.
- Tips for Energy Savers - Available from the Office of Marketing and Education Presents some simple and practical advice for saving energy. 5,600,000 copies printed.
- 21. Tips for the Motorist - Available from the Office of Marketing and Education Presents tips on how to reduce car fuel consumption. 5,000,000 copies printed.
- 22. Western Regional Energy Development Study. Aug., 1975 Primary Environmental Impacts (1150 pages total)
 - Executive Summary NTIS PB 246-267
 - Volume I NTIS PB 246-264
 - Volume II NTIS PB 246-265
 - Appendices NTIS PB 246-266

Examines the primary environmental impacts of thirty-eight energy resource development scenarios, including all aspects of development, and projects the level and impact of pollutants. 75 copies printed.

Mr. Hemphill. Thank you very much, Mr. Chairman. With your permission, I would like to insert my full statement into the record and read it in a slightly abbreviated form.

Mr. RYAN. You may do so.

Mr. Hemphill. We are funding a number of programs on an experimental basis, and we plan to review carefully the results of these initial efforts before making recommendations about future funding levels.

For example, in the residential sector, Project Conserve is one means by which we have attempted to provide information to the homeowner. It is based on a questionnaire which can be completed by the homeowner. The questionnaire is processed by a computer and a report is then provided to each homeowner indicating the conservation measures he or she should take, and estimating the costs and savings that can be

expected.

We have already conducted pilot tests in a number of communities, and have chosen, on a competitive basis, two States—Massachusetts and New Mexico—for the next stage of implementation. Of the nearly 1 million homeowners who received the questionnaire in Massachusetts in April, 14.8 percent have returned a completed form and are receiving their individualized results. New Mexico homeowners will be contacted this fall.

Let me just add that a 14.8—almost 15—percent return rate on a direct mail questionnaire which asks somebody to do something and send it back is a very substantial return rate. We are delighted with

those results.

A companion effort, the home energy savers program, is to be implemented this fall in 10 States. This program will develop and distribute a workbook to enable homeowners to evaluate and compute the energy efficiency of their own homes. The workbook will be supported by a media campaign which includes a 30-minute retrofit film for public

service television.

In the institutional sector, which is composed of buildings owned by Government or other nonprofit organizations, we have begun several programs designated to improve energy efficiency in elementary and secondary school buildings. In September of 1974, FEA funded the development of a computer-based technical service, called the Public Schools Energy Conservation Service, for test marketing in selected school districts. The service will inform a district what the present level of energy use is in each of its school facilities; what that level should be; and how to proceed to achieve the suggested energy use level.

We also awarded a \$170,000 contract to the American Association of School Administrators to perform an energy audit and fully retrofit 10 elementary schools across the country as a demonstration of what can be done in existing school buildings. And the Office of Buildings Programs is currently collating for analysis the results of an energy survey of 10,000 school districts. The results of this survey should provide the basis for new policy initiatives to encourage energy conservation in schools.

Incidentally, the Public Schools Energy Conservation Service, or PSECS, methodology has already been applied in about 2,000 school buildings, and has given some fairly useful results in terms of energy

auditing.

In the commercial sector, for more than one year, we have been contacting owners, managers, and tenants of existing buildings through our regional offices to inform them of the simple steps they can take to save energy in their buildings—such as eliminating unnecessary lighting and adjusting temperature and ventilation levels.

In addition, we have focused on the need to design energy efficiency into new commercial buildings, as well as all other buildings. We have retained the American Institute of Architects Research Corp. to develop materials and a program to bring energy consciousness into architectural practice and into architectural education at the university level. A design competition was also initiated, and the results of this competition, as well as the professional education program for practicing architects, were incorporated into the AIA 1976 annual convention program.

There are a number of other programs which are in the development stages. The most important of these is our voluntary standards program, the goal of which is to support State activities in the development and implementation of standards for the construction of new buildings. Under the Energy Policy and Conservation Act, signed by the President last December, a program of grants to States was established

to support State-run energy conservation programs.

One of the five requirements a State must meet to qualify for this funding is the adoption of mandatory thermal efficiency standards for new and renovated buildings. Another requirement is the adoption of

a lighting efficiency standard for existing public buildings.

To assure effective implementation of such programs at the State level, we must be prepared to deliver technical assistance in the form of training programs for code officials and other materials describing the process of adopting and enforcing an energy building standard through local codes. We are coordinating this effort with other agencies, most notably ERDA, HUD, and the National Bureau of Standards.

Our information on how energy is used in the buildings sector has so far been adequate to identify the major savings potential and to justify the programs which we have so far implemented. Much of this information is either a year or two old, or is of a general nature. Sometimes the data is not available in as much detail as we would like to have it.

In the residential sector, for example, we know from privately funded marketing surveys that at least 20 million single-family homes in this country are inadequately insulated; but, we do not have specific information on the regional distribution of these buildings, or even on the level of thermal improvement activity currently taking place.

Even before the 1973 embargo, the administration saw an opportunity for the Federal Government to set an example for energy conservation in buildings by cutting its energy consumption. This was achieved through the Federal energy management program. Through relatively simple conservation measures, such as turning out unnecessary lights and adjusting thermostats, and through minimizing use of ships, aircraft, and vehicles, the amount of energy used by the Federal Government was reduced by 24 percent.

This reduction, equivalent to more than 250,000 barrels of oil per day, continues because of the hard work and dedication of hundreds

of managers and thousands of employees in the executive branch who, by the way, I believe deserve more recognition and credit for this ac-

complishment than they have generally received.

The easy steps have been taken. We must recognize that moving forward will require long-range planning. Nevertheless, the move must be made because the Federal Government is itself a large energy user and because we will never convince large segments of the public that they must work toward greater energy efficiency unless we ourselves are making a meaningful and visible effort. It is both possible and reasonable to constrain the level of energy use in the Federal Government in fiscal year 1985 to no more than we are currently using.

A 10-year plan for energy conservation in Federal buildings is now being developed as mandated in the Energy Policy and Conservation Act. The plan is designed to insure that buildings owned or leased by the United States meet mandatory lighting and thermal efficiency standards, as well as insulation, thermostat control, and other requirements. A close look will be given to the procurement policies of Federal agencies to see that they meet new Federal energy conservation standards now being developed. Plans also will be developed to replace or retrofit existing Federal buildings.

The budget history of the Office of Conservation and Environment, as a whole, and particularly of the Office of Buildings Programs, has

been one of continuous change.

The Administration requested \$86.6 million for conservation and environment in fiscal year 1976—more than six times the level requested for fiscal year 1975. This request was reduced, however, to \$46.7 million by the Congress. As you know, the recently passed appropriation for Interior and related agencies contained \$25 million for the first year of the State Energy Conservation Plan under EPCA. Again, this is only half the \$50 million Congress authorized and the Administration requested for fiscal year 1977.

The amount of funds available for FEA's conservation and environment programs, as a whole, in fiscal year 1977, including the \$25 million for State programs, is \$34.7 million. Because of the reduced level of appropriations, the Office of Buildings Programs will probably have to eliminate its support of some of the initiatives I have outlined

here today and further reduce others.

Though it is now 3 years since the Arab oil embargo, the critical need for energy conservation still exists. Despite the funding difficulties our office has experienced during the past 1½ years, we still believe that those programs that prove to be effective on a small scale will eventually be expanded to a national scale to meet this national need.

Sir, we would be happy to try to answer any questions you may have on anything in the statement or on any other general conservation matters.

Mr. Ryan. In your statement, you said that 37 percent of all energy used in the United States is consumed in the buildings sector.

What did you mean by that?

Mr. Hemphill. If you add up the total final energy consumption in the country and you break it out by the end uses to which it is put, you will find that 37 percent of it is used in buildings. Specifically, it is used for heating, cooling, lighting, and hot water heating. The use of appliances would be included in that total as well.

Mr. RYAN, I think that statement probably indicates the reason we are having the hearing. I was afraid that was what you meant. And I do not think that even begins to look at the real problem.

You are considering the use of energy after the building is built. It takes money and it takes energy to manufacture all of the materials that go into the building, does it not?

Mr. Hemphill. Yes, sir.

Mr. RYAN. Have you calculated what part of the total consumption of energy in this country that is?

Mr. Hemphill. Not really. That energy is only consumed once, so

it does not show up year after year as a consumption figure.

Mr. RYAN. But it is energy, wouldn't you say?

Mr. Hemphill. Yes, sir, but it is counted in the industrial sector because that is where it is consumed.

Mr. Ryan. Let me give you an example. As of October of 1973, as far as I am concerned, most buildings in this country were more or less obsolete because they were built on the presumption, which we have always had in this country, that no matter where the materials come from, there are more. And all we have to do is go and get it.

And yet, the whole push for ecological development or conservation of natural resources presumes that we are going to better use the materials that we have left on this planet—until we find a planet unlike Mars or the Moon that has something besides just plain rock, at least.

If we are going to begin talking about conservation of energy, it seems to me that we have to build buildings that don't become obsolete the day they are completed. And one of the functions of FEA ought to be to get into this area. That, apparently, has not occurred to you yet. And it has not occurred to GSA, that I know of, either.

What is the cost, for example, in energy for the construction of a

single-family residence? Has anyone even looked at that?

Mr. HEMPHILL. It certainly costs more to build a single-family residence than it does to build a single unit of a multifamily residence. Mr. Ryan. Obviously it does; we can assume that. But are you look-

ing for any kind of figures such as that?

Mr. HEMPHILL. We have no contracts currently funded to look at

However, that question has been raised before and we have plans to

look at it as the contract money becomes available.

Mr. RYAN. May I suggest that until you do that and until you conclude that that is where you have to go, I will be on your back pretty hard. I have even invented a term for it. We have ergs as a measurement of energy; we have ohms as a measurement of resistance to electrical energy. And, we have a "ryan." That is a new term for you.

A "ryan" is like a dollar. It is an expenditure of energy—so much for so much to build so much. And then you can express the construction of this building, or a similar building, in terms of two thingsdollars and "ryans." And "ryans" would indicate the amount of energy, in units, it takes to build the building. And if it is not done efficiently and carefully, and if the cost is too much, the answer is "No."

You had a cut in your budget down to \$25 million. Do you know why? It is because nobody likes what you are doing. Nobody thinks what you are doing has much value. I think the general attitude on the Hill toward FEA is-and I share it-that you are not going to get any more money, but that you are going to get less and less until we phase you out, if we have to, unless you show us some reason to con-

tinue your existence.

What we want to see is not congressional pushing and shoving. We are trying to get that done too; and I recognize the shortcomings here. But I did not see one word at all in your statement of things which the executive branch can do by Executive order to make your-

selves more energy efficient.

You are fast enough to order people through regulations in the Federal Register to do all kinds of things they may or may not want to do. We certainly hear from businessmen about that every day. But what have you ordered yourselves to do? And what do you plan to order yourselves to do in order to make yourselves more energy efficient right away and in the long run?

Mr. Hemphill. Would you like some examples?

Mr. Ryan. I would love some examples.

Mr. Hemphill. First of all, let me reiterate that by Executive order we set up the Federal energy management program. And we have now reduced the Federal Government's total consumption by 24 percent.

That is better than any other sector—private or nonprofit. Nobody has made a 24-percent cut over fiscal year 1973. There is no one who

can match that performance.

Mr. RYAN. How much of that is DOD and how much of that is GSA?

Mr. Hemphill. Lots of it is DOD. DOD is the major energy consumer.

Mr. Ryan. But what I am hearing is that DOD has canceled training flights; they have canceled necessary surveillance flights over particular areas; and, in fact, they have reduced the level of what they consider to be adequate defensive measures taken in surveillance, as well as in other training measures, which they believe to be in the dangerous sector.

But I do not want to talk about that nearly as much as I want to talk about other agencies outside of Defense and what they have done.

Mr. HEMPHILL. It is not my understanding that DOD has, in fact, done anything which in their judgment imperils national security by reducing energy use.

Mr. RYAN. In your judgment?

Mr. Hemphill. In their judgment, sir. Mr. Ryan. That is not what they tell me. Mr. Hemphill. That is what they tell us.

Mr. Ryan. Then we will just note the difference and go on.

Mr. Hemphill. They have gone to an increased use of flight simulators.

We have, by Executive order, raised the HUD minimum property standards level, which apply to the FmHA, VA, and FHA financed loans. This involves about 15 percent to 18 percent of the housing in this country. This is raised to a level which is equivalent to the ASHRAE 90–75 standards; and means, in essence, that you have to have a better insulated house now to get an FmHA, FHA, or VA loan.

We are about to promulgate regulations which require that every new car purchased by the Federal Government must get 18 miles per

gallon.

Mr. RYAN. Do you have any standards which say, if a building is not energy efficient enough, that you cannot build it?

Mr. Hemphill. We have plans underway to make those standards

law. We are developing those at this point.

Mr. RYAN. What constitutes "energy efficiency"? Is it determined simply by how much heat you keep in a building, or how much cold

you keep in a building?

Mr. Hemphill. That, in fact, is a tough question to answer. There are a lot of people who are more interested in what could be called component standards. For example, how well does this furnace work? How well does this air-conditioning system work?

Mr. Ryan. Do you have any plans for the condemnation of buildings

that are too energy inefficient?

Mr. Hemphill. We plan to retrofit, on priority order, the least efficient or the most leaky, old buildings.

Mr. Ryan. What do you mean by "retrofit"?

Mr. Hemphill. We plan to tighten them up, put in more insulation, put in storm windows, where appropriate, and put in more efficient heating systems.

Mr. Ryan. That does not answer my question. Do you have any plans or any criteria for the condemnation of buildings which are impossible

from a conservation standpoint?

Mr. Hemphill. Truthfully, I suspect that that may well be part of the program. But the program and the plan which we are required to submit is not yet fully formulated. So I cannot give you a firm

answer. It is certainly worth looking at.

Mr. Ryan. I ask that because in sitting right here in this room, I observe that this is a very energy inefficient room. The ceiling is too high; the lighting is more than enough. And I would imagine that if you went through and began to set up new standards and new criteria that you would find that most buildings in existence today are simply energy inefficient.

Mr. Hemphill. Absolutely.

Mr. RYAN. This building has a high ceiling primarily because that

has been the custom in this country for some 200 years.

My own experience in California, with the high Spanish ceilings, indicates that that is the way you keep a building cool. When you build a high ceiling, the hot air rises to the top and the cool air comes to the bottom. That is really neat—providing it isn't air-conditioned. But when you air-condition it and still have high ceilings, it becomes a little stupid.

And yet, we are still building buildings that have high ceilings because it looks nice. That includes everything from Federal court buildings and courtrooms to, I suppose, congressional hearing rooms,

as well as others.

Mr. Hemphill. You may be interested to know that the General Services Administration is building two particularly energy efficient buildings as models, just to prove they can do it.

Mr. RYAN. Where are they?

Mr. HEMPHILL. One is in New Hampshire and one is in Kansas.

They will serve as Federal office buildings.

Mr. Ryan. Those are not in what you would call centers of population where great numbers of people may see them and take courage from the example, are they?

Mr. HEMPHILL. I am not sure that GSA functions that way. I think that if the buildings work, they will know and then they will build more efficiently.

Mr. Ryan. What control of policy do you have over GSA today?
Mr. Hemphill. It is another agency of Government. I would say
that we do not have as much control over them as you have.

Mr. RYAN. Do you have any policymaking suggestive power?

Mr. HEMPHILL. Certainly.

Mr. RYAN. What do you suggest to them?

Mr. HEMPHILL. We have suggested some of the things that I have mentioned to you. And they have been very cooperative in terms of some of the transportation initiatives. Also, they have played a major role in moving in and getting their building managers—and they, by and large, are the managers of Federal buildings—to delamp and take out lighting fixtures and to turn down thermostats.

Of the Federal buildings with which I am familiar, some people are complaining that it is a health hazard to walk down the halls because of the low lighting levels. I think that is a bit overdone. But that pro-

gram has been reasonably successful.

But those are the easy things. The hard things are the things which cost money. To go in and retrofit is expensive. For example, we work in the new Post Office Building. It is new only in comparison to the old Post Office Building, which was built in 1880. The new Post Office Building was built in 1938. It has one thermostat for the whole building of seven floors. I would scarcely be able to venture an estimate of the cubic footage.

When the temperature is at our suggested 68 degrees on the third floor in the office of the Administrator, in the winter, it is about 75 degrees or 80 degrees on the seventh floor. And if you get down to 68 degrees on the seventh floor, it is down around 55 degrees in the Administrator's office. And God knows how cold it is on the first floor.

The same problem occurs in reverse order with air-conditioning. What you really need to do is to go in and tear out the whole heating and cooling system. You need to reinsulate the place. And that would cost a lot of money.

We have looked at it a couple of times because it is embarrassing for the Administrator to work in this crumby building. But it would cost a lot of money. And it would take the building out of functioning for

a year. So those are the disincentives.

Mr. Ryan. There are two elements to be considered—one of which you have touched upon slightly; and another which you have not. The first concern is the efforts and activities in which you are now engaged to handle current needs. But I have not yet heard about what you are doing from some given day, at some time after October of 1973, to see that every building built by the executive branch of the Federal Government must comply with certain energy requirements, both for their heat and energy needs and consumption after they are built, and also in the manner in which they are built and the kinds of materials they use.

Mr. Hemphill. Let me try to answer that again.

The major suggestion which we have made is that the Federal Government develop and promulgate mandatory energy efficiency standards for all new construction—residential, commercial, Federal Government, State government, local, profit, and nonprofit.

Mr. RYAN. But you have said already that it had more to do with

the keeping of the heat in and the cold out than anything else.

Mr. Hemphill. That is a critical concern. The amount of energy used in the construction of the building, by and large, is a small fraction of the energy it uses over its life.

Mr. Ryan. I do not see how you can say that when you don't know

how much it is.

Mr. Hemphill. We have looked at these things in a number of areas.

We looked at it in automobiles, for example.

And given the fact that buildings are around for between 30 and 40 years, if you take the dollar costs of building versus operating, and you assume that that has some relation to energy use, which it does, it is reasonably clear that the energy used in operating the building is greater.

Mr. RYAN. We are building buildings in the area of Washington right here and now. They tend to be built, very heavily, of brick, I

notice.

How much brick is consumed by the average house built in the Washington metropolitan area; and how much energy is consumed in making that brick?

Mr. HEMPHILL. I don't have any idea.

Mr. Ryan. Is that much energy necessary? Is that much brick nec-

essary? Is there a better way to build it?

Mr. Hemphill. Unquestionably, there is a better way to build it. In terms of the energy used in making the brick, we do have some programs in the industrial area which set targets for various industries, such as the stone, clay, and glass industry—whatever the standard industrial classification code is. This is one of the industries for which we will set a target for reducing the energy used per brick made.

Mr. RYAN. Which, in terms of the manufacturing, is more efficient-

brick or steel?

Mr. HEMPHILL. Per pound?

Mr. Ryan. Which is more efficient in terms of area covered?

Mr. Hemphill. I do not have the exact figures, but I would bet you anything that brick is more efficient. It is cheaper. And if it is cheaper, it is likely to use less energy.

Mr. Ryan. Buildings which are being built in large metropolitan areas such as New York, where we had the Democratic convention, are primarily steel and glass. When I lived there as a kid, it was mortar.

Are those more costly, then, from an energy standpoint? If so, is any effort being made today to discourage that kind of construction?

Mr. Hemphill. The answer is "yes." They are both more costly to build and to operate. And, Congress willing, we will take significant steps to discourage their construction. But it requires that we promulgate—and unfortunately it is a Federal regulatory activity—regulations which say, "OK, no more than x amount of energy per square foot in the operation of this building."

And we may well look at the construction too. I just do not know

enough about that to answer your question adequately.

But once those standards are promulgated, every building built in this country will meet them or else they will not be built. But we need that authority. We do not yet have it.

Mr. Ryan. It seems to me that there is a lag here between what the Congress does and what the regulatory agency does. If you look

at the Federal Register and note the number of regulations that come spewing forth every day, the lack of progress so far in this area is inconsistent. And then you say that you can't do it here or you can't do it there.

I am not saying that Congress isn't interested and won't cooperate to provide some kind of standard. But I find it interesting that you run for help from Congress whenever you find yourselves a little

short.

But basically, I think that what it comes down to is that energy and conservation, as construed by the Federal energy agency so far, consists too much of turning off lights and turning down the thermostat. These are things that need to be done, but they are only band aids being applied to a cancerous wound that is going to kill us in the end if we do not substantially change the whole way we live.

And that begins with the design of buildings. That is why we have some architects here today to give us some of their advice and counsel.

Mr. Hemphill. I don't think I disagree with you in that our initial efforts were certainly focused on that. But that seems to me to be logical. Those things, you could in fact do quickly and cheaply.

The idea of changing every building now built or going back and reinsulating the 15 or 20 million homes that we know are not well insulated is a substantially more complicated and, frankly, more ex-

pensive proposition.

It does not cost a thing to turn down your thermostat or take out a light bulb. But it costs quite a bit to put in 6 inches of attic insulation and storm windows and storm doors.

Mr. RYAN. That is true. The reason the poor family does not do

it is because they do not have the money.

Mr. HEMPHILL. That is right. And we have submitted legislation which would provide us \$55 million a year to pay for exactly those things for poor families.

Mr. RYAN. Is that enough? How much do you need?

Mr. HEMPHILL. It is not enough. It depends upon your estimate of how many homes there are. That will do 1½ million homes. But there are probably closer to 5 million that need to be done in terms of low-income houses. But it is a start.

And that has not passed either. Mr. Ryan. I am aware of that.

In your statement, referring to a 10-year plan, you say that the plan is designed to insure that buildings owned or leased by the United States meet mandatory lighting and thermal efficiency standards.

That, again, is a little like saying that you and I will cook a dinner, and you will bring the salt. There is a little more involved, in essentially trying to change the manner in which this country lives and exists, than meeting lighting and thermal efficiency standards. To me, that avoids looking at the much larger problem of the construction of buildings themselves, and which consume enormous amounts of energy and which are inefficient.

Mr. Gude, do you have any questions?

Mr. Gude. You say in your statement that the Administration requested \$86.6 million for conservation and environment in fiscal year 1976—more than six times the level requested for fiscal year 1975. You

go on to say that this request was reduced, however, to \$46.7 million by the Congress.

Where are the cuts being made to reflect this reduction in appro-

priations?

Mr. Hemphill. Sir, we received some direction from the Appropriations Committees as to the kinds of cuts which they wanted made. For example, we had planned, through a nationwide effort, to take our Project Conserve questionnaires to homeowners. These would be received by homeowners, filled out, sent back in, and then there would be a computerized printout of what they should do. That has now been cut back to two States.

We had planned to go to every large building owner in the country with seminars to encourage him to do the things that most large building owners still have not done in terms of energy consumption. That has been cut back to 140 seminars. We have scrunched everything down

to meet that level of funding.

Mr. Gude. In regard to Project Conserve, where you send out these questionnaires, what type of followup have you had as to their effectiveness?

How many of the people who send in the questionnaires and receive the computer printout actually follow through by making improvements to their homes. And of those, to what extent do they follow through?

Mr. Hemphill. Let me explain a little of the history of the program

in order to give you a complete answer.

We field tested this first in two locations—Topeka, Kans., and Danbury, Conn. There was limited distribution; it was a small program. And we did some evaluation of pricisely the things which you are talking about. That is the bottom line. And that is what you want to know.

Our indications were that of the people who received their forms back, about 10 percent took action on the recommendations within

the form.

We now have a much more substantial demonstration effort in Massachusetts and in New Mexico. We plan to carefully evaluate that, using well-controlled statistical techniques in terms of sample size and so forth, to confirm again, in fact, that people do not just take the information and sit on it. It does not do us any good to hand out information if nobody does anything about it. But we are reasonably convinced that we will have some substantial, measurable impact.

Mr. Gude. And you say that 10 percent of the people who received

the computer printout actually took some kind of action?

Mr. Hemphill. That is not exactly right. It is 10 percent more than the control group. We evaluated this against a group of homeowners who did not receive the questionnaire. And out of that sample, about 30 percent of those who did not receive the questionnaire at all took some insulation action. Forty percent of the people who got this thing back took action. So we had 33 percent improvement over the people without the questionnaire.

Let me add one thing. We do not think that Project Conserve, of and by itself, is going to make everybody in the country run out and buy insulation. We have always envisioned it as being linked with a tax credit for residential homeowners, which the President proposed 11/2 years ago, and which has now passed the House and is in the Senate

Finance Committee's tax reform bill.

If you combine the information of what to spend the money on with a tax credit which will pay you back some of the money that you spend, we think the results will be of a substantial amount of homeowner retrofit.

Mr. Gude. Of that 10 percent, do they take steps which fully implement the recommendations that are returned to them? What is the

percentage of efficiency that you get from that 10 percent?

Mr. Hemphill. I do not think we have the answer to that. We will have to go back and look at the evaluation. As I recall, it varied across the board. Some did everything; some did a couple of the cheapest and excited things.

and easiest things.

The output of the actual sheet gives you some ability to make the choices because it gives you some range of what the savings are and what the costs are. And this may be limited by available cash in some instances.

Mr. Gude. And you have said that you are going ahead with additional pilot projects in Massachusetts and New Mexico.

Mr. Hemphill. Yes, sir.

Mr. Gude. What is your rationale for making an additional survey? Is there any reason to believe that you will get better results on a new survey when all of the other factors are the same? You still do not have the legislative authority you seek.

Mr. HEMPHILL. Our rationale was that that was all we had the

money to do.

I think the project is a valuable expenditure of Federal dollars in and of itself. It is not terribly expensive. And if you run the cost of this program out against the cost of the barrels of oil that are saved, even with the 10-percent improvement rate, you will find that you have a substantial savings in terms of dollars per barrel of oil saved.

We can provide you those figures, but I think it is down well below

\$2 a barrel in terms of savings.

Mr. Gude. Suppose Congress fails to pass the tax incentive? Do you still consider this a cost effective program, and will you continue with it?

Mr. Hemphill. It is, in fact, one of our more cost effective programs—even without the tax credit. And I think whether we continue it or not is entirely dependent upon whether the appropriations are there to continue it. It is one of the better things we have done.

Mr. Gude. If, with the operation of this program, you get a 40-

percent improvement, what about the other 60 percent?

Mr. HEMPHILL. That is why we need the tax credit, I guess.

Mr. Gude. Thank you, Mr. Chairman.

Mr. Ryan. Is there any written material—any orders given or any work done—to set up some kind of standards with regard to what the Federal Government itself does in the renting and construction of

building for its own use?

Mr. Hemphill. We have an Executive order, for starters, which sets out some of these things. And we are in the process of developing both the standards and the procedures which the Federal Government, that is GSA, will be required to follow in renting, leasing, buying, and so forth.

Mr. Ryan. Do these regulations include the kinds of building materials to be used and the architecture of the building to be built?

Mr. Hemphill. They are not yet fully developed, so I cannot really

tell you what they include.

Mr. Ryan. Do you take those two considerations into your planning? Mr. Hemphill. We certainly will—given your interest.

Mr. Ryan. But you haven't up until now? Mr. HEMPHILL. I am not certain of that.

Mr. Ryan. I would like to have the answer to that as soon as possible. I think it is an extremely important part of any consideration. If the Federal Government cannot provide by example what others are to do, there is not much that is going to be done.

Mr. Hemphill. Let me explain one difficulty to you. And probably the people from AIA may want to touch upon this in more detail.

When you get into the business of regulating things like this, you are faced with two choices. You can regulate at the front end and say: "No more buildings built out of steel and glass. They are all going to be brick and masonry because we know that is more efficient." Or, you can regulate on the output end, which is to say: "We do not care how you guys build it, but we do not want it to use more energy, either in construction or in operation, than x per square foot."

People who have to live with those standards—the architects and engineers and guys who finance buildings and the makers of glass and steel, and perhaps makers of brick—would generally prefer to come out with output standards. And I think that is a more rational public policy. I am not sure it is the Federal Government's business, necessarily, to tell somebody that he cannot build a steel and glass building

anymore.

If someone develops a wonderfully efficient steel and glass building, I am not sure that we—and I do not know that you do—wish to subject ourselves to the kind of outcry that would arise if the Federal Energy Administration had just prescribed standards which said, "Sorry, it must all be brick and mortar."

Do you see the difference that I am trying to draw?

Mr. Ryan. I see your point. But I think that if you had the truth on your side, the least you can do is make the comment. If you are knocked down in the process, the least you can do is make the effort.

Mr. Hemphill. The truth about technology, though, is that technology changes. And if we were to promulgate regulations this year which prescribed only brick and mortar, we would probably have to revise those regulations every 6 or 12 months, as the technology for making steel and glass or aluminum or whatever improved.

Mr. Ryan. I am sure that if we carried that kind of argument very far, Columbus would still be sitting on the dock waiting for somebody

to give him an idea about how to get over there.

I think what you have to do is make the move with the best information you have. And according to the best information we have now, we are losing millions of tons of natural resources every year which are used even when we know that they are not the most efficient means of construction.

And if the Federal Government itself cannot begin to order, within its own area of total authority, changes which have, at least in theory,

some value, we are in pretty sad shape.

Let me ask you one last question. Are there any plans—excluding for the moment any execution—to build a building that is energy efficient both in terms of its use of energy after it is built and energy efficient in the sense that the materials from which it is constructed are such that would make it inexpensive?

Mr. Hemphill. The short answer is "No." The somewhat more detailed answer is that GSA, whenever it builds a building, looks very carefully at the first cost of the building. And it tries to get the

cheapest building that can be built.

By and large that tends to be the building with the least energy intensive materials in it. Energy intensive materials are more expensive.

Mr. Ryan. Having seen some judges' chambers, I would question

that—among other places.

Who has the final authority when the crunch comes between FEA and GSA? Can FEA override GSA in any kind of building plans?

Mr. Hemphill. No, sir.

Mr. RYAN. Do you think it would do any good if you could?

Mr. Hemphill. It seems to me that a directive from the Congress, such as the one we already have, would be a lot more effective than giving one Federal agency the ability to override another one.

Mr. Ryan. Wait a minute. You are the Federal Energy Administration. If you tell GSA that it is doing something which is very expensive from an energy standpoint and that they, therefore, should stop doing it—even if you cannot enforce it, should you not voice it?

Mr. Hemphill. Surely. I think we may have given you the wrong impression. The General Services Administration has been very cooperative on this whole set of energy concerns. They operate, as do most Federal agencies, under a set of fairly specific statutes, however. And there are some things that they flatly cannot do because they are not legal.

They are working and we are working to change some of those things. And we have other laws which have been enacted which will set up the kind of standards that you are talking about—at least in operation—so that new buildings which are built will in fact be more

energy efficient.

Mr. Ryan. If I may paraphrase George Orwell, some things are more illegal than others. And I have not been in government this long without knowing that sometimes when you don't want to do something, you hide behind the law. And when you really want to do something, you ignore the law and go ahead, if you think it is good enough for you.

I think it is important here not to talk about the law as such and to talk about violating it or not violating it, but it is important to

find out, in effect, what you need to do.

And if you can show me something which you would like to do; which you burn to do; which you desire to do, but which you are kept from doing by the illegality of it, please write me a letter and say: "We would love to do this, but it is illegal. Will you help us."

Mr. HEMPHILL. All right. Let us take a look at that and see if, in fact, we have real legal impediments to some of the things we think need to be done. And we will certainly give you our judgment on that.

Mr. RYAN. We could go on much longer, but there is more which the committee has to get into. I appreciate your being here today. And I hope that the dialog thus far gives you an indication of the interest of this subcommittee and of the direction in which it is going

to go.

I can assure you that this is simply the first of a series of hearings on this matter because it is one which I consider to be the most important single matter before the Federal Government today. And I am talking about things that are terribly important—anything from damming or not damming wild rivers to strip mining and a lot of other things which we can and will get into.

But until we learn to change the way we think about how we build the buildings in which we live and work, we have not done much. And the Federal Government, as far as I am concerned, ought to take the lead by example and show others what they can do if they choose

to do so.

Project Conserve and all of those other programs are just great. But they remind me of the kinds of things we used to do during World War II—things like putting bumper stickers on cars and all kinds of things to keep our morale up. "Eat less meat; try vegetables instead."

These were things designed to get us through a particular period of crisis during a war and when we had our backs to the wall. There is no war going on now. And there is no end to this. It will never cease.

This planet is running out of gas. It is running out of energy. It is just a question of time. Therefore, how we spend what we have is of crushing importance—not just to us, but to my kids, and to the next generation, and to the generation beyond that. They will have to live in a world that is much more bleak in its prospects if we do not spend ourselves much more carefully than we do now.

That is why we are here. And this committee, as long as I am around anyway, will consider this to be the No. 1 priority of what we do.

It is for that reason that what you do is of great interest to me. And I intend to continue to ask for and to call you in from time to time to ask what you are doing.

Mr. Hemphill. We certainly look forward to those opportunities.

Mr. Ryan. Thank you.

[Mr. Hemphill's prepared statement follows:]

PREPARED STATEMENT OF ROBERT F. HEMPHILL, JR., ASSOCIATE ASSISTANT ADMINISTRATOR, ENERGY CONSERVATION AND ENVIRONMENT, FEDERAL ENERGY ADMINISTRATION

Mr. Chairman and members of the committee, I welcome this opportunity to appear before you to discuss energy conservation in buildings. I would like to begin my testimony today by reviewing with you some misconceptions about conservation.

Conservation is not simply curtailing energy use. It is not a change or lowering of our life style. Nor is conservation allocation, or rationing, or some other form of Government imposed restriction. Conservation is not a no-growth policy,

nor solely an environmental concern.

In the buildings sector, conservation generally means two things. First, it means a set of capital investments in existing facilities which tighten up building shells, making heating and cooling equipment more efficient, and pay for themselves in a predictable number of years. This sort of conservation, in short, is nothing more than capital investment justifiable on traditional economic grounds. Training, education and information programs for the owners and operators of

commercial and residential buildings are typical of the second sort of conserva-

tion in existing buildings.

Despite considerable evidence demonstrating the economic benefits of energy conservation, many Americans still seem to be asking. Why do we need conservation? The short answer is that because of declining supplies of fuels like natural gas and petroleum and an increasing cost of producing and supplying energy, conservation is vital to sustain our standard of living and economic growth.

Why does conservation not proceed at a faster rate? The first reason is that the American people are used to cheap energy and, compared to the rest of the world, much of our energy remains cheap. In the United States today, the price of gas is about 60¢ per gallon; in Paris it sells for about \$1.50 per gallon. In Europe, high fuel costs have resulted in massive public and private efforts to reduce the energy waste in buildings, but in the United States, because prices are not yet at European levels and because conservation has not had enough advocates in the business sector, neither Congress nor the private sector has yet taken the necessary steps to achieve energy efficiency in buildings.

Conservation in buildings in the U.S. will not be a simple matter. In many aspects, it will be more complex and difficult than encouraging increased domestic energy production. While only several thousand companies produce and distribute our energy, millions of businesses, institutions and individuals consume it. Still, it is vital to make the effort because 37 percent of all energy used in the U.S. is consumed in the buildings sector. The Nation's 67 million occupied housing units, of which some 47 million are single-family homes, account for 70 percent of the

energy need in the buildings sector.

Commercial and other non-residential structures account for the remaining 30 percent of the energy consumed in the buildings sector. Typical of these structures are office buildings, warehouses, educational buildings, hospitals, and State and local public buildings and colleges. Altogether, there are 24 billion square feet of commercial space. These buildings serve a wide variety of functions. Moreover, their ownership is often backed by complicated financial arrangements. For these reasons, achieving energy conservation in the commercial sector is particularly complicated.

In January 1975, the President proposed a number of measures addressed to energy conservation in buildings. He stressed that cutting long-term energy consumption was just as important as increasing energy supplies. He proposed a bill to make thermal efficiency standards mandatory for all new residential and commercial buildings; he proposed a new tax credit of up to \$150 for homeowners who install insulation; and he proposed a program to weatherize 1.5 million low-

income family homes.

Eighteen months later, we do not have the tax credit or the building standards or the weatherization bill. We hope these measures will be passed before Congress adjourns this fall. This is an especially serious matter for the low-income families in the Nation. Those families of four with annual incomes of only \$5,500 per year spend an estimated 11 percent of that income on home energy use—about \$600. FEA is ready to quickly implement the weatherization program. Without the program, high energy bills will force many of these families to cut back

on basic necessities in order to keep warm in winter.

These Presidential proposals are, by and large, Government incentives to encourage private action. The Administration also recognizes there is a lack of reliable information on the costs and benefits of specific conservation measures and has consequently instituted programs which would provide such information to the private sector. Because energy conservation is in the economic self-interest of virtually all energy users, our programs have emphasized the provision of detailed information on proven conservation measures rather than arbitrary controls on energy use. The intent of the programs has been to reduce energy consumption to the maximum extent possible with existing technology, while also minimizing the cost to the Government.

All of our buildings programs have been closely coordinated with other Federal agencies, including the Energy Research and Development Administration (ERDA), the National Bureau of Standards in the Department of Commerce, the Department of Housing and Urban Development, and others. This coordination takes many forms, including regular staff contacts, joint funding of projects of mutual interest, and active participation in the Energy Resources Council, which

serves as a mechanism for high level coordination of energy policy.

In general, the mandate of ERDA is the research, development and demonstration of new, more energy-efficient technologies. FEA's mandate is to achieve

widespread adoption of conservation technologies and practices which are com-

mercially available at present.

Mr. Chairman, we have prepared a document describing our programs which I would like to summarize and include as part of the Committee record. It is entitled, "Buildings Programs-Energy Conservation and Environment." I would also like to submit to you a copy of the First Quarterly Report on FEA Energy Conservation Programs which we provided to the U.S. House and Senate Committees on Appropriations in April 1976.

We are funding a number of programs on an experimental basis and we plan to review carefully the results of these initial efforts before making recom-

mendations about future funding levels.

For example, in the residential sector, Project Conserve is one means by which we have attempted to provide information to the homeowner. It is based on a questionnaire which can be completed by the homeowner. The questionnaire is processed by a computer and a report is then provided to each homeowner indicating the conservation measures he/she should take and estimating the costs and savings that can be expected. We have already conducted pilot tests in a number of communities, and have chosen on a competitive basis two States, Massachusetts and New Mexico, for the next stage of implementation. Of the nearly one million homeowners who received the questionnaire in Massachusetts in April, 14.8 percent have returned a completed form and are receiving their individualized results. New Mexico homeowners will be contacted this fall.

A companion effort, the Home Energy Savers Program, is to be implemented this fall in ten States. This program will develop and distribute a workbook to enable homeowners to evaluate and compute the energy efficiency of their own homes. The workbook will be supported by a media campaign which includes a

30 minute retrofit film for public service television.

In the institutional sector, which is composed of buildings owned by Government or other non-profit organizations, we have begun several programs designated to improve energy efficiency in elementary and secondary school buildings. In September 1974, FEA funded the development of a computer-based technical service called the Public Schools Energy Conservation Service (PSECS) for test marketing in selected school districts. The service will inform a district what the present level of energy use is in each of its school facilities; what that level should be; and how to proceed to achieve the suggested energy use level. The Office of Buildings Programs also awarded \$170,000 to the American Association of School Administrators to perform an energy audit and fully retrofit ten elementary schools across the country as a demonstration of what can be done in existing school buildings. And the Office of Buildings Programs is currently collating for analysis the results of an energy survey of 10,000 school districts. The results of this survey should provide the basis for new policy initiatives to encourage energy conservation in schools.

In the commercial sector, for more than one year, we have been contacting owners, managers and tenants of existing buildings through our regional offices to inform them of the simple steps they can take to save energy in their buildings; such as eliminating unnecessary lighting and adjusting temperatures

and ventilation levels.

In addition, we have focused on the need to design energy efficiency into new commercial buildings, as well as all other buildings. The Office of Buildings Programs retained the American Institute of Architects (AIA) Research Corporation to develop materials and a program to bring energy consciousness into architectural practice and into architectural education at the university level. A design competition was also initiated, and the results of this competition as well as the professional education program for practicing architects were

incorporated in the AIA 1976 Annual Convention Program.

There are a number of other programs which are in the development stages. The most important of these is our Voluntary Standards Program, the goal of which is to support State activities in the development and implementation of standards for the construction of new buildings. Under the Energy Policy and Conservation Act, signed by the President last December, a program of grants to States was established to support State-run energy conservation programs. One of the five requirements a State must meet to qualify for this funding is the adoption of mandatory thermal efficiency standards for new and renovated buildings. Another requirement is the adoption of a lighting efficiency standard for existing public buildings. To assure effective implementation of such programs at the State level, we must be prepared to deliver technical assistance in the form of training programs for code officials and other

materials describing the process of adopting and enforcing an energy building standard through local codes. We are coordinating this effort with other agencies, most notably ERDA, HUD, and NBS.

In other program areas, we are proceeding through the preliminary stages of program development to deliver information to owners of health care facilities of various types. We also plan to develop an energy conservation manual for the

use of builders of single-family homes.

Our information on how energy is used in the buildings sector has so far been adequate to identify the major savings potential and to justify the programs which we have so far implemented. Much of this information is either a year or two old, or is of a general nature. Sometimes the data is not available in as much detail as we would like to have it. In the residential sector, for example, we know from privately funded marketing surveys that at least 20 million single-family homes in this country are inadequately insulated, but we do not have specific information on the regional distribution of these buildings, or even on the level

of thermal improvement activity currently taking place.

Even before the 1973 embargo, the Administration saw an opportunity for the Federal Government to set an example for energy conservation in buildings by cutting its energy consumption. This was achieved through the Federal Energy Management Program. Through relatively simple conservation measures such as turning out unnecessary lights and adjusting thermostats, and through minimizing use of ships, aircraft and vehicles, the amount of energy used by the Federal Government was reduced by 24 percent. This reduction, equivalent to more than 250,000 barrels of oil per day, continues because of the hard work and dedication of hundreds of managers and thousands of employees in the Executive Branch who, by the way, I believe deserve more recognition and praise for this accomplishment than has generally been accorded them.

The easy steps have been taken. We must recognize that moving forward will require long-range planning. Nevertheless, the move must be made because the Federal Government is itself a large energy user, and because we will never convince large segments of the public that they must work toward greater energy efficiency unless we ourselves are making a meaningful and visible effort. It is both possible and reasonable to constrain the level of energy use in the Federal

Government in FY 1985 to no more than we are currently using.

A ten year plan for energy conservation in Federal buildings is now being developed as mandated in the Energy Policy and Conservation Act. The plan is designed to ensure that buildings owned or leased by the United States meet mandatory lighting and thermal efficiency standards, as well as insulation, thermostat control and other requirements. A close look will be given to the procurement policies of Federal agencies to see that they meet new Federal energy conservation standards now being developed. Plans will also be developed to replace or retrofit existing Federal buildings.

In addition to the program functions which the Office of Buildings Programs has instituted, that Office has performed support functions for the Assistant Administrator of Conservation and Environment. For example, in the area of building standards for new construction, the Office has funded a study of the impact of the so-called ASHRAE-90 Standard developed by the American Society of Heating, Refrigerating, and Air Conditioning Engineers, I have included a

copy of this study for the Committee's use.

In support of the President's tax credit proposal, the Office has cooperated with the National Bureau of Standards (NBS) to produce recommended criteria for retrofit materials and products eligible for the tax credit. Further funding has been budgeted to complete the work which is contained in the preliminary paper produced by NBS.

The budget history of the Office of Conservation and Environment, as a whole, and particularly of the Office of Buildings Programs, has been one of continuous

The Administration requested \$86.6 million for conservation and environment in Fiscal Year 1976—more than six times the level requested for FY 1975. This request was reduced, however, to \$46.7 million by the Congress. As you may know, the recently passed appropriation for Interior and related agencies contained \$25 million for the first year of the State Energy Conservation Plan under EPCA. Again, this is only half the \$50 million Congress authorized and the Administration requested for Fiscal Year 1977. The amount of funds available for EPA's conservation and environment program, as a whole, in FY 1977, including the \$25 million for State Programs, is \$34.7 million. Because of the reduced level of appropriations, the Office of Buildings Programs will probably have to eliminate its support of some of the initiatives I've outlined here today and

further reduce others.

Though it is now three years since the Arab oil embargo, the critical need for energy conservation still exists. Despite the funding difficulties our office has experienced during the past year and one-half, we still believe that those programs that prove to be effective on a small scale will eventually be expanded to a National scale to meet this National need.

Mr. Ryan. Our next witness is Mr. Leo A. Daly.

Mr. Daly, will you state your name and occupation for the record, please.

STATEMENT OF LEO A. DALY, FAIA PRESIDENT OF LEO A. DALY CO., CHAIRMAN OF THE NATIONAL ADVISORY COUNCIL ON RESEARCH IN ENERGY CONSERVATION AND PAST CHAIRMAN OF THE AMERICAN INSTITUTE OF ARCHITECTS, ENERGY STEERING COMMITTEE; ACCOMPANIED BY JAMES P. FEENEY, RESEARCH ANALYST, CHARLES W. WILLIAMS, INC.

Mr. Daly. Mr. Chairman and members of the committee, it is a pleasure to outline for you my thoughts on the great potential which energy efficient buildings offer for resolving the Nation's energy dilemma. You are to be commended for directing attention to this

most important topic.

We urgently need to achieve a nation of energy efficient buildings within the next 15 to 25 years. During this period, energy savings will become especially critical. If such savings are to occur, we must have comprehensive, organized leadership for a closely integrated, high priority national program of action. Unfortunately, such a program exceeds the scope of any legislative committee of Congress, any executive department or agency, and any private corporation, institution, or industry. If this committee takes the needed comprehensive strategic approach, it can fill a vital leadership role.

My prepared statement is short, Mr. Chairman, and it summarizes my personal views gained through over 4 years of research and analysis on matters pertaining to energy conservation and the built environment. During this time, I have served as the president of a major architectural and engineering firm, chairman of the energy steering committee of the American Institute of Architects, and chairman of the National Advisory Council on Research in Energy Conservation.

Additional supporting details on the subjects covered in this statement are contained in the documents which I have brought along for

your review. Specifically, these documents are:

No. 1, an AIA published report entitled: "Energy and the Built Environment: A Gap in Current Strategies;"

No. 2, a second AIA published report entitled: "A Nation of Energy

Efficient Buildings by 1990;"

No. 3, an unpublished staff study prepared for the AIA, entitled: "Proposal for and Analysis of an Interim Legislative Strategy to Achieve a Nation of Energy Efficient Buildings by 1990;"

No. 4, an executive summary of another unpublished manuscript prepared for the AIA entitled: "A System to Achieve Energy Efficient

Buildings: Demonstration Plan;" and

No. 5, the first annual report of the National Advisory Council on Research in Energy Conservation entitled: "Energy Conservation Research: A Key to Resolving the Nation's Energy Dilemma."

[The material follows:]

ENERGY AND
THE BUILT
ENVIRONMENT:
A GAP IN
CURRENT
STRATEGIES
THE AMERICAN
INSTITUTE OF
ARCHITECTS

FOREWORD

Earlier this year I asked Leo A. Daly, FAIA, chairman of the Insti-tute's Task Force on Energy Conservation, to report to me on his personal findings, and observations regarding this critically im-portant subject. I did so because I felt that, while the task force was pursuing its work, members of the AIA—indeed members of all the descriptions. all the design professions—needed to be better informed about the nature and dimensions of the energy crisis and the role they might

play in its solution.

I am delighted that I made the request, because Daly's report is. I believe, an important and far-reaching document, it shows, quite convincingly in my opinion, how sustained efforts to achieve energy efficiency in the built environment can make a significant contribution toward solving our nation's energy crisis, and it proposes specific programs for bringing these efforts about. Daly hise done his homework well. His report is the result of intensive research and study carried out by himself, by a research consultant whom he commissioned, and by associates in his firm, with backup and support provided by members of the AIA staff. The report is being distributed to all AIA members to their review and discussion. It will also be made available to other members of the dealing professions, to legislators and other government officials, and to private citizens concerned with this issue.

Daly's report, which represents his sown viewpoints, designates to

Daily's report, which represents his own viewpoints, deserves to be read, studied, and discussed. I recommend it not only to members of the AIA, but also to all those whose actions and decisions affect the way we use energy.

Archibald C. Rogers, FAIA President, The American Institute of Architects

INTRODUCTION

In the fall of 1972 Max O. Urbahn, FAIA, who was then president of the American Institute of Architects, asked me to chair a task force to explore waye in which the design professions could contribute to the solution of the energy problem and to develop appropriate methods to involve the AIA membership in this endeavor. Members of the task force are George T. Heery, Frithjor M. Lunde, Richard G. Stein, FAIA, and Herbert H. Swinburne, FAIA. The Task Force on Energy Conservation has made an important contribution to the Institute's work in the area of energy. I would like to stress, however, that the presenter report reflects my own observations on the energy question. In preparing this report I have been concerned not only with the question of energy conservation in the built environment, but with the entire energy problem. While the presentation is personal, its observations summarize extensive work, including an independently commissioned preliminary strategic policy evaluation of the national energy problem. The present strategies for solving the the American Institute of Architects, asked me to chair a task force

national energy problem, the present strategies for solving the

problem, and the opportunity offered by a national program for energy conservation in the built environment.

This experience has given me a deep appreciation for the depth and complexity of the energy problem and for the great opportunity the design professions have to make a significant contribution toward its solution. The degree of the potential contribution of our members is substantially greater than 1 had originally supposed, but then so is the severity of the problem itself. The magnitude of the energy problem is such that it is not regulated to suppose that it the energy problem is such that it is not realistic to suppose that it can be adequately encapsulated in a form as concise as this sumnary. However, I will endeavor to reduce the most critical issues to brief, understandable terms.

To brief, understandable terms.
These are the basic conclusions I have reached:

1. The energy problem is a long-term problem whose resolution is possible—but only through austiend, multifaceted approaches.

2. Every individual in the building design and planning professions will be profoundly affected by the solution of the energy problem over the next several decades; if these individuals are to provide their most worthwhile services to their clients and committee they will need a comprehensive profession.

problem over the next several occades. It mese individuals are to provide their most worthwhile services to their clients and communities, they will need a comprehensive perspective on the dimensions of the problem and their role in 8s solution.

3. The building design and planning professions are important links in the nation's solution to the interpretation of the short and long term.

4. Public and private policymakers need to understand the potential offered by the building design professions because it is they who ultimately will determine whether architects, engineers, and planners are allowed to make their maximum contributions.

5. The general public also needs to be informed about the important place of buildings and land use in long range solutions, because ultimately the approaches adopted will be based more on political than technical decisions.

6. Present energy policies, with their emphasis on increased supply, seriously underplay the important role of conservation in general and of conservation in the build revivorment in particular. This imbalance results in forfeiting major opportunities for better investment of the nation's energy resources.

This impassance rostes in internal heavy characteristics investment of the nation's energy resources.

7. Energy conservation in buildings has such potential magnitude and near-term developmental possibilities that it warrants an immediate high-priority national program. The potential compares favorably, in terms of equivalent energy availability, with the potentials of the domestic petroleum industry, the notices power industry, the notices are projected to exist in 1900.

8. Because the energy problem is now so visible, the rush to remedial action increases the risk of wasted and counter-productive efforts. We must learn a great deal more than we know now before we can confidently inject rigid energy standards into building design codes or other forms of legislation.

9. The American institute of Architects should immediately take the initiative to form a private-sector forum and the coordinative mechanism to provide the needed leadership in developing strategies for energy conservation.

tegies for energy conservation

These conclusions summarize the results of a comprehensive

analysis of the energy problem as it retates to the built enviro The presentation of this analysis is organized under the

following headings:
A. A Conceptual Framework for Evaluating Energy Policy

B. A Quantitative Perspective: Energy Supply/Dem C. A Note About Strategic Evaluation D. A Deeper Look at Present Policies and Priorities

An Alternative Strategy: The Compelling Case for Energy Conservation in Buildings
F. Toward a Strategy for Energy Conservation in Buildings
G. An Action Plan

A. A CONCEPTUAL FRAMEWORK FOR **EVALUATING ENERGY** POLICY

The way one conceives of a problem determines the framework within which its solution is formulated. If the energy problem is viewed as only a temporary interruption in supply, then the building design professions might lend their expertise and coursel to a series of conservation efforts, such as turning down thermostats, adding insulation, and installing storm windows. On the other hand, If the problem is seen not simply as a question of temporary supply shortfalls, but as a more fundamental change caused by our anomals, our as a infer surfacemental range caused by our moving from an ear of abundant, cheap energy into an ear of scarce, expensive energy, then the building design professions must consider sweeping changes in their attitudes about how building systems interface with energy supply and consumption. nt information indicates an era of energy scarcity.

DEFINING THE ENERGY SYSTEM: Man intervenes in nature to acquire energy that will fulfill his needs and desires. River flows are captured to produce electricity which in turn can provide heat or cooling. But the same heat or cooling is more likely produced from burning coal, petroleum, or natural gas. This suggests that the energy systems created by man are of two types. (1) those that reorganize natural forces in a manner that gives energy as a byproduct, and (2) those that represent a permanent conversion of energy stored by nature in one form into a consumption unit which represents not a by-product of natural forces but a permanent exchange of a nonrenewable natural resource.

These two types of humanly developed energy systems might be called (1) man-organized energy systems and (2) man-made energy systems. A key distinction between these two is that the first draws upon renewable resources while the second

draws upon nonrenewable resources. We might think of the former sources as nature's current income accounts and the latter as nature's capital accounts. dominated human existence. Animal power and the diversion of

iral processes were the principal sources of energy to do man's natural processes were the principle sounds of energy work. With the advent of the steam engine, electricity, and the industrial revolution, mechanical energy generated from fossil fuels caused more intensive energy conversion.

fuels caused more intensive energy conversion.

Energy consumed from both of these systems is regarded as a consumption good—meaning that the more of it that is consumed the better. Yet, we can clearly see that in the case of man-made energy, the energy is a consumption of capital. In most economic evaluations, capital is regarded as something to be conserved. But thus far we have not evolved economic incertives to recognize this feature as it relates to goods (including energy) that represent permanent can recise to glocos producing energy that represent permanent conversions of nonrenewable resources: nature's capital. This difference in accounting concepts makes a profound difference in the economics of energy systems and particularly in the economic incentives of conservation versus consumption, Within the past 100 years main's energy systems have shifted from those dominated by nature's current income accounts (man-

organized energy) to systems dominated by nature's capital accounts (man-made energy).

The contemporary energy problem is contained in these man-organized and man-made systems. This calls for a closer look at how these systems are organized. There are five basic subsystems

The World Inventory of Energy (stored in capital accounts

B Energy Source Acquisition Systems (mining oil wells.

Intermediate Conversion and Distribution Systems (electrical generating plants, oil refineries, pipelines, electrical trans-D. End-Point Consumption Systems (heating and cooling

Environmental Exchange Systems (residual effects of ob-

ining, processing, and using energy).
From this perspective, we can define the energy problem as

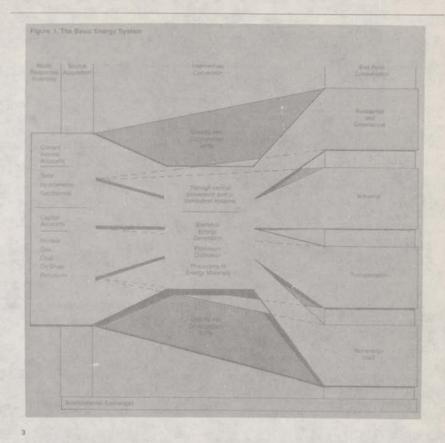
-Acquiring sources for the adequate supply of energy raw ma-

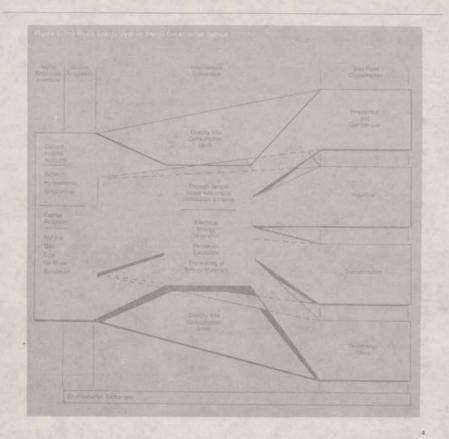
Determining what demands are to be fulfilled, at what price, and in what manne

in what manner.

—Linking these supply and demand relationships technologically through some form of "optimal efficiency" in terms of need or demand, cost, and resource management.

—Maintaning acceptable environmental exchanges balanced in terms of the consumption of limite natural resources, the restoration of natural balances upset by man's intervention (such as strip mining), and the way in which residuals or pollutants are dealt with. The present "energy industries" generally assumed to comprise the energy system are concentrated in the processes of source acquisition, conversion, and distribution—almost exclusively from nature's capital accounts. The problem of balanced energy strategies and policies is compounded by institutionalization along the lines of the raw materials utilized, i.e., petroleum, coal, natural gas, and nuclear power. These concepts are illustrated in Figure 1.





Policy formulations, whether originated in government or industry, now evolve around economic principles in which the lacentives ultimately encourage more, rather than less, consumption. This helps explain why an effective and well-financed national strategy emphasizing energy conservation is not now a long-term objective. An understanding of this subtle but important reality is essential to understanding the economic and political dimensions of policies that would seek to shift the focus from "more consumption is good" to "less consumption is good".

DEFINING ENERGY CONSERVATION IN BUILDINGS: The preceding concepts suggest the following definition of energy conservation in buildings: The reduction of energy demand through the elimination of waste and the substitution, to the degree feasible, of on-alle generation and regeneration capacity within an independent decentralized acquisition and conversion system that draws on nature's current income.

More specifically, energy conservation in buildings includes.—The reduction of energy consumption in buildings by changing behavior: lowering thermostats in winter and raising them in summer, reducing twells of lighting, and a variety of other rationing efforts. Short-term success in behavior changes of this type may be quite high, as has been the case with gasoline and electricity during the current crisis. However, experience has shown that the long-term success in effecting such behavioral change is generally low. It is, therefore, not a reliable nor even desirable strategy, but should be reserved for the short-term crisis in which hardships are more readily accepted if there is relief in sight.

—The reduction of energy consumption in buildings through increasing the efficiency of the buildings as an energy-saving mechanism. Through appropriate design, construction, and management, buildings can be made to consume substantially researchy without any basic impact on their users.

—Reduction of the demand upon energy raw materials from nature's capital accounts through substitution of nature's current income sources captured through on-site acquisition and conversion systems. This conceptualization of the diversified, decentralized energy conversions systems important. If one considers changing the concept from large, centralized acquisition, conversion, and delivery systems (which is the current structure) to a decentralized, smaller-scaled, site-oriented system, insofar as that can go toward fulfilling energy demands, then current technologies aftering substantial conservation opportunities are already available. In fact, these technologies are at a more advanced state of proved feasibility than many of the more elaborate large-scale technological alternatives that are receiving more priority and most of the funding. These observations and their implications will be discussed in more detail later.

Figure 2 shows how this definition of energy conservation in buildings fits into the conceptual model of the energy system shown in Figure 1.

These opportunities for conservation programs that reduce traditional demand requirements for energy to operate buildings have not been considered in the projections on which present policies are been.

B. A QUANTITATIVE PERSPEC-TIVE: ENERGY SUPPLY/ DEMAND PATTERNS

Figure 3' shows the basic energy supply/demand patterns within the United States during the past 120 years. It also shows what the future demands will be if past trends are continued. The large boost in energy demands that began in the 1940s was a takeoff point. Between 1946 and 1965 the average annual growth rate in consumption was 3.1 percent, resulting in a doubling time of 23 years. But between 1965 and 1970 the annual growth rate averaged 5 percent, which implies a doubling of the 1965 consumption in only 14 years. Electricity, a system that now loses about two-thirds of its energy input as waste, is the most rapidly growing source of energy delivered to the consumption units. The annual growth rate in electrical consumption averaged 7.6 percent from 1940 to 1970 — an average doubling time of only nine years?

U.S. energy consumption between 1950 and 1970, broken down according to sources of energy raw materials, shows the degree to which man-made energy dominates the present system (see Figure 4).³

Buf the key to understanding the energy problem rests not so much in the picture of the past as in what the future patienns are likely to be. A 1972 Congressional analysist lists: 35 energy-demand studies made by a variety of government and private organizations between 1960 and 1971. All of these forecasts were inaccurate if put into a context of 10 to 20 years. For example, Figure 5 shows the rate at which the various forecasts for total energy consumption in 1980 have fluctuated just since 1960. Considering that in many of the energy supply systems the lead time for building capacity is seven to 10 years, one can readily grasp the tack of strategic reliability exhibited by policies formulated in 1962 based on the then current projection to 1980. The error most common to these forecasts is their consistently low estimates of usage.

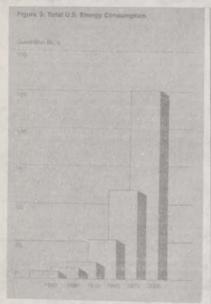
estimates of usage.

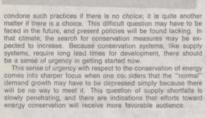
It was after 1968 that these studies began to express serious concern about the capacity to fulfill the expected energy demands, and no serious attention was paid to developing coordinated and balanced national energy policies until the current crists hit. In policy formulation, including the present policies, the demand curves are generally considered served requirements. Thus

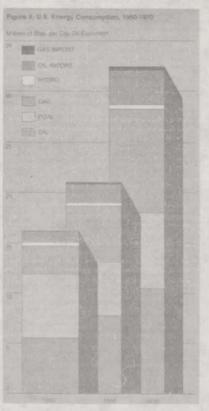
in policy formulation, including the present policies, the demand curves are generally considered sacred requirements. Thus, policy concerns are overwhelmingly biased toward how to generate increased supplies of energy. These attitudes allow to go unanswered questions about what energy demands should be considered legitimate requirements.

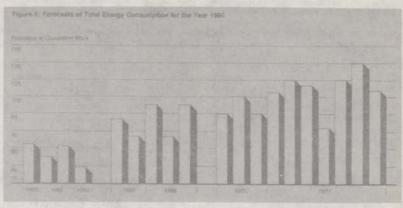
considered legitimate requirements.

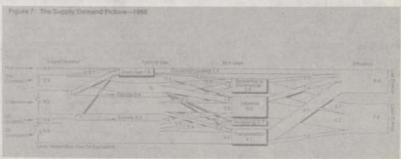
A serious question arises, for example, about the wisdom of withdrawing billions of units of nonrenewable resources to supply buildings with 30 percent to 50 percent more energy than they need just to accommodate the level of inefficiency generated by present building practices. It is one thing to

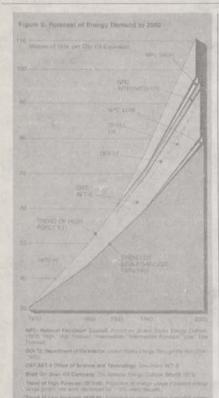












The Joint Atomic Energy Committee of Congress recently evaluated the probable capabilities of the nation to increase its supply of energy from both current and prospective technologies. The committee used forecasts below the extrapotations from recent growth rates (see Figure 6). Assuming the successful installation of the Ataska pipeline, nuclear energy, shale conversion, and the other remedies being discussed currently, it was estimated that even the low forecast would be accommodated in 1990 only by a heavy retinance on imports. These calculations were converted to a common denominator of millions of barrels of petroleum per day equivalents, with the relationships between sources, convenion systems, and consumption.
Figures 7, 8 and 99 show the results of these calculations for 1950, 1970, and 1990. All of the charts are plotted on the same vertical scale. Note that if the extrapolation of current growth in demand were reduced by about 30 percent (as shown by the difference between the high and low forecasts on Figure 6), a substantial supply gap would remain to be filled, in these projections, by imports. The Joint Atomic Energy Committee of Congress recently evalu

tions, by imports.

Thus, a strategy to conserve energy is not in competition with the present energy industries nor with present efforts to increase the supply capacity of these industries. Rather, it is a complementary, commonsense effort that offers substantial promise for helping to meet anticipated demand requirements, and for minimizing the economic and social costs of any crises resulting from unexpected supply problems.

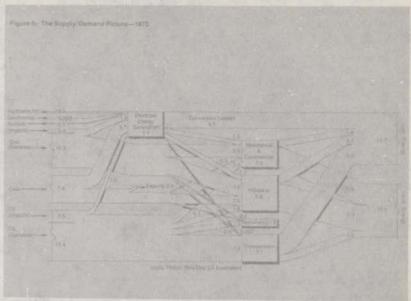
C. A NOTE ABOUT STRATEGIC **EVALUATION**

Far too often, in trying to resolve problems not nearly as complex as the energy problem, the nation has pumped billions of dollars into priority efforts that were later found to have been illi-advised. I have been impressed with the difference in perspective one gets with respect to what should be done immediately if he steps back and looks at present policies and alternatives as if

he steps back and looks at present policies and alternatives as if they were longer-term strategies.

This means that we first assume that present policies will prevail for the next two or three decades. A principal advantage of this mode of thought is that it permits us to examine carefully whether or not the path we are following will lead where we wish to go. In short, will we regret what we are doing now when we look back on it 10 or 20 years from now? I should emphasize that the purpose of such long-range considerations is solely to improve the quality of choices we make about what is to be done now.

improve the quality of changes we make soon that is one opportunities for immediate steps that otherwise would be overlooked because they appear so small in contrast to the dominant activities of the present. It now appears that energy conservation in buildings talls into this category. Its potential within the next three to five years, when evaluated against the magnitude of the current energy



problem and when cast beside the enormous quantities of energy needed, looks too small to warrant a major thrust. But, if this perspective is extended 10 or 20 years, we see that in terms of needed supplies, energy conservation in buildings ofters opportunities on a scale that, if present estimates prove reliable, few reasonable men would reject.

Strategic thinking permits us to capture the principles of compound interest that apply to policy strategy just as they apply to savings and investment. For example, a change of only 6 percent a year will result in the 100 percent transition of a system within just 12 years if this change is pursued as a sustained and coherent strategy. But if the changes are a series of shorter-term jerks associated with reactive, crisis-oriented policymaking, we

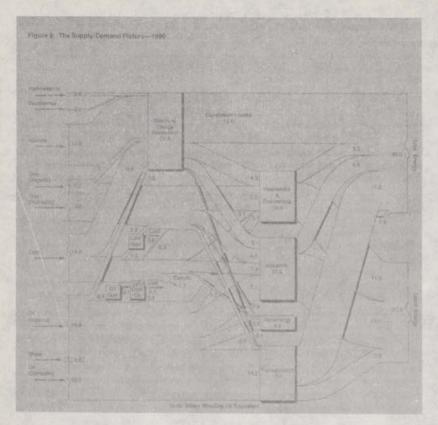
not only lose the value of the compound interest, but also often much of the original principal.

Finally, the strategic perspective allows us more time to adjust policies that, though they have been adequate for years, will become less adequate or desirable in the future.

We can say that the most desirable national energy strategy would point us in the following basic directions:

—From reliance on man-made energy systems toward reliance on man-organized energy systems, i.e., from energy converted from nature's capital accounts toward energy diverted from nature's capital accounts.

—From inefficient energy systems that waste energy in either conversion or consumption processes loward more efficient systems.



-From activities that generate environmental pollution toward ecologically closed systems that minimize the undesirable environmental impacts

From increasing reliance on centralized generation and distribution systems, with the problems of vulnerability and conversion losses they entail, toward decentralized, site-oriented energy sys tems flexible enough to utilize a variety of alternative

-From the potential risks associated with nuclear power (how ever acceptable they may be represented to be) toward less risky

were ducephase usey many de represented to be lower less risky. I could develop a longer list, but these principles suffice to provide a framework for an evaluatory statement about present policies and the desirability of a strategy emphasizing energy conservation in the built environment.

D. A DEEPER LOOK AT PRESENT POLICIES AND **PRIORITIES**

A good idea of current energy strategies is obtained from ex-amining the priorities given to the research and development ex-penditures considered necessary to solve the energy problem within the next several decades.

within the faxt several decades.

In Figure 10° I have recast the President's recently announced five-year energy program into the conceptual model of the energy system shown in Figures 1 and 2. This shows the overwhelming priority being given to extending existing man-made supply systems that consume nonrenewable resources (operate from nature's capital accounts).

capital accounts).

Just 6.5 percent of the proposed five-year program is allocated to end-point consumption, and the majority of this sum involves increasing the efficiency and flexibility of the transportation sector. Only \$200 million of the monies in this five-year program of nearly \$11 billion is allocated to research and development on energy conservation in buildings. This budget overlooks major opportunities in conservation that offer more certain returns and higher cost benefits than many of the other investments. These opportunities will be discussed to prove detail.

These opportunities will be discussed in more detail.

Present policies contain only modest provisions for exploring opportunities that could help to move us in the strategic directions desired. The dominant priority continues to carry us down the path we trod to arrive at our present predicament. This increases the chance that 20 years hence we will regret that a more balanced. strategy and set of priorities were not started today

E. AN ALTERNATIVE STRATEGY: THE COMPELLING CASE FOR ENERGY CONSERVA-TION IN BUILDINGS

To relate the total energy consumed just in building-related operations, we must combine the residential and commercial sec-tors as shown in Figures 7, 8, and 9 with the portion of the indus-trial sector that involves building operation.

Data compiled by the Stanford Research Institute provide a basis

for this combination,* Figure 11 shows estimates provide a session of the ratios of energy consumption expressed in trillions of Btu's for 1968. Buildings account for 3.6 percent of the total.

Assuming that these relationships remain essentially stable, the

application of these same ratios to the estimates in Figures 8 and 9 gives us an approximation of the millions of barrels of oil per day equivalent consumed in building operations in 1970 and p nd for 1990

jected for 1990. The potential savings in energy conservation in buildings are still somewhat ambiguous, with estimates ranging from 25 to 50 percent in older buildings and between 50 and 80 percent in new construction. The higher figures incorporate on-alte energy generation from nature's current income accounts, site energy generation from nature's current income accounts, usually solar. I should emphasize that these conservation opportunities are available within existing technology and knowledge. The only stumbling blocks to their implementation are either economic, political, or attitudinal, in the interest of being conservative, I have taken 30 percent as the average potential energy savings in old and new buildings.

and new buildings.

and 60 percent as the average potential energy savings in old and new buildings.

Applying these percentages to the estimated consumption in 1970 and 1990, 1 derive an estimated potential savings of 4.1 million barrels per day of petroleum equivalents in 1970 and 12.5 million barrels per day of petroleum equivalents in 1980. Applying a dollar value of 36 per barrel in 1973 and a very modest \$12 per barrel in 1990, these calculations result in an estimated economic value of saved energy of \$9 billion and \$54.8 billion for each of the two years (see Figure 12).

These gross savings result from not consuming energy that would otherwise have been wasted, the amortization of additional building costs required to obtain these savings is not included. Estimates of these costs range up to 33 percent. If This would have increased the cost of new construction in 1971 by \$36 billion, or about four times the potential annual savings in 1970. Of course in more refined estimates this \$36 billion would be offset against the reductions in capital required to produce the energy to be wasted. Also, the capital and operating costs required to control or remedy the pollution that waste would entail would be added to the savings. to the savings.

Fig. 10: Energy Research Budget Trends (Millions of Alchers)								
	FY.1973	4	PF 1904	-	FY 1975	4	PY 75-79	- 1
Supply	\$647.8	88	\$834.1	. 86	\$1,332.1	77.5	8-8315.0	75.9
Conversion and distribution	15.2	2	32.8	3	163.3	9.5	1,185.0	10.8
END-POINT CONSUMPTION Oversit system and	64.4	9	82.1	9	105.7	0.1	705.0	6.6
environmental interface	1.6	0	1.7	0	119.9	8.9	745.9	0.8
Total	\$729.0	100%	\$950.7	100%	\$1,721.0	100%	\$10,960.9	100%

F	gure 11: Re	ettos of Ener	rgy Consum	ption		
	Conjumption () (Iffice) of Store)		Retwork growth (percent)	Percent sit		
	1960	1968	ger year)	1960	1966	
Residential						
Space heating-	4,848	6,675	4.136	11.3%	11.0%	
Witer heating	1,159	1,736	5.2	2.7	2.0	
Cooking	556	637	1.7	1.3	1.1	
Clothes drying	93	206	10.6	0.2	0.3	
Refrigeration	369	692	8.2	0.9	1.1	
Air conditioning	134	427	15.6	0.3	0.7	
Other	809	1,241	5.5	1.9	2.1	
Total	7,968	11,616	4.8	18.6	19.2	
Commercial						
Space heating	3,111	4,182	3.8	7.2	6.5	
Water heating	544	655	2.3	1.3	1.3	
Cooking	98	139	4.5	0.2	0.2	
Retrigeration	534	670	2.0	1.2	1.1	
Air conditioning	576	1,113	8.6	1.3	1.8	
Feedstock	734	984	3.7	1.7	1.6	
Other	145	1,025	28.0	0.3	1.7	
Total	5.742	8,766	5.4	13.2	14.4	
Industrial						
Process steam	7,646	10.132	3.6	17.6	16.7	
Electric drive Electrolytic	3,170	4,794	5.3	7.4	7.9	
processes	486	705	4.8	1.1	1.2	
Direct heat	5.550	6,929	2.6	12.9	11.5	
Feedstock	1,370	2,202	6.1	3.2	3.6	
Other.	118	198	6.7	0.3	0.0	
Total	18,340	24,960	3.9	42.7	41.2	
Transportation						
Fuel	10,873	15,008	4.1	25.2	24.0	
Raw materials	161	146	0.4	0.3	0.3	
Total	11,014	15,184	4.1	25.5	25.2	
National total:	43.064	60.526	4.3	100.0	100.0	

Cincon 45. The Reducted Offi-		W		
Figure 12: The Potential Office (expressed in milli	ons of ha	mergy Conse mels of oil so	rvation suivalen	In Buildings
		1970		1990
Total consumption		29.7		57.5
Amount consumed in opera- tion of buildings (33.6)*		10.0		19.3
Add: The amount of energy loss in intermediate con- version processes using centralized large-ecide spectrical generation in which the loss is approximately gd%.				
Electrical demand con- sumed in buildings Total requirement	13		4.3	
electrical generation	3.8	0.8	12.6	12.6
Total energy consumption in operation of buildings including generation of electricity at centralized Tacility		13.8		31.9
Potential savings with a high- priority conservation program	r.			
Estimated potential for	30			
Estimated potential for new	percent 60	4.1	6.7	
building stock (assuming about 30% of building stock in 1990 will be built after 1973)	percent		5.8	12.5
Dollar value of potential savings per day (i) \$6 per berrel in 1973 and \$12				
barrel in 1990 (1973 dollars) Annual dollar value of		\$24.6 million		\$150 million
potential savings		\$ 9.0 billion		\$54.8 billion

There will be those who correctly point out that the present data base for these estimates has gaps and is questionable the combination of

taking savings estimates at the lower end of the present range; using a conservative estimate for price increases;

using a conservative estimate for price increases;

 inporing the savings in capital costs associated with having to
 generate the energy in the first place, which may essentially neutralize the additional building costs;
 excluding estimates for cleaning up or controlling pollution
 generated by the wasted energy; and

generated by the wasted energy, and —ignoring the trends that show that the proportion of the total energy going into buildings is increasing, leads me to believe that the estimated savings can be regarded as reasonable. These could be annual savings which recur year

Since policy formulation is so heavily oriented toward supplying energy, and since the realization of these savings is equivalent to an increase in that supply. It can be clearly seen that energy conservation in buildings deserves as significant a place among-energy supply alternatives as do the domestic petroleum industry, the natural gas industry, the nuclear power industry, and the coal industry (see Figure 13).

The conservation process?

The conservation potential of buildings is nearly equal to the forecasted shortfall in supply, or about two-thirds of the im-ports projected. Thus, whether considered as a trade-off in competition with other investment opportunities or as a complementary opportunity to reduce the projected shortfalls, the statistics clearly indicate a compelling opportunity which war-rants a high-priority national program. More confidence can be assigned to this position when we recognize that the same comclusion would emerge even if the actual savings were to be sub-stantially less than these estimates.

F. TOWARD A STRATEGY FOR **ENERGY CONSERVATION** IN BUILDINGS

An initial and understandable reaction to the question of what to do is to advocate the development of a set of procedures — a field manual — which can become the text that specifies what the building engineer or designer should do.

The fact that many of these energy-conserving procedures are commonsensical has led some to believe that it would be relatively easy to produce a set of prescriptive standards. This seductwery easy to produce a set of prescriptive standards. This seduc-tive idea of simple, straightoward, no-noisence action may lead to a variety of actions that will later prove to be counterproductive or at least not the best choice. The risk of these nonproductive outcomes is significantly higher when collateral drives begin for incorporation of these procedures into energy standards for local building codes and other legislative instruments. The basic points are:

Within the present state of knowledge we do not know exactly how, and under what conditions, certain actions might be

Even if we did know these details, the variations of building situations would tend to make a "standards approach" effective.

3. We lack adequate knowledge of the psychological and physiological relationships of some energy-conserving tactics.

4. We can specify many things that might conserve energy.

but at increased costs of operation.

There is a need for and value in lists as idea-joggers, but the greater need is for individualized professional evaluation of each potential conservation measure as it relates to the highly variable and often difficult-to-measure factors unique to a particular build-

INITIAL CRITERIA FOR A CONSERVATION STRATEGY: First, INITIAL CRITERIA FOR A CONSERVATION STRATEGY: First, there needs to be an extension of the principle of self-sufficiency. The President has proclaimed a national objective of self-sufficiency, meaning that the United States should become capable of supplying itself with all of the energy it needs by 1980. The previous discussion on the supply-demand projections shows how difficult it would be to reach that goal. Present policies will have to be substantially modified to make it possible. One such modification is the extension of the concept of self-sufficiency first to conservation in buildings and then to the remainder of the built environment.

The building unit should be as "self-sufficient" as possible. should import the minimum amount of energy required to fill its energy gap after it has utilized as much as it can of the energy available on site. It should emit the minimum amount of waste into external systems

Figure 14 illustrates a comparison between the present and the proposed concepts. Present concepts:

—Generally treat the building system or site development as a somewhat independent entity which levies a demand upon a series of external and independent energy supply systems.

—Do not explainable how the building systems.

Do not evaluate how the building unit relates to overall energy demand systems

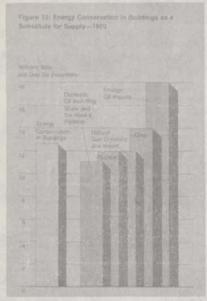
Generally disregard the effects of discharges into either the

—Generally diaregard the effects of diacharges into either the natural environment (thermal pollution) or other independent external processing systems (sewage).

Each of these various systems consists of a variety of subsystems which are generally specialized in both concept and operation. Under this concept, any recycling or ecologically closed system entails such emerging brends as using solid waste for fuel within a central energy-generating plant.

Proposed concepts illustrated on the bottom half of Figure 14 show how this would change under a response of expenses of the process of the process

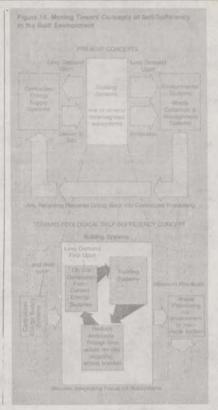
Proposed concepts illustrated on the bottom half of Figure 14 show how this would change under a principle of maximum self-sufficiency beginning at the level of the building. The building is considered as an entity that will, to the degree possible, use man-organized systems of energy acquisition, employing as much as possible of the natural energy in which the building exists.



Waste and pollution would be regarded lirst as something to be recycled internally, emitting only that which is not digestible internally or which, by wirtue of its characteristica, can be recycled more efficiently or more desirably by going into a centralized processing facility. Thus the building design principle would be one in which a minimum import and minimum export of net energy demands and net operating residuals becomes a basic objective.

energy demands and net operating research cooling to be objective.

What is entailed is a reverse hierarchy in which one starts with the concept of self-sufficiency at the smallest unit — the building, — and then progressively applies the principle outward to the site plan, to adjacent site plans, to districts, to regions, to entire towns or cities, and then ultimately to national systems.



Second is the recognition that only energy from nature's current income accounts (man-organized energy systems) is legitimately considered a consumption good, and only then to the degree that it does not increase environmental pollution

Third is the consideration of diversitied, low-intensity, de-centralized energy conservation and generation systems as the first line of energy acquisition—particularly elince the energy required for building operation is generally of much lower intensity than that required for manufacturing processes. It should be emphasized that this is a complementary and not a competitive concept. The centralized system would still be needed as a reserve capacity for buildings and would serve as the prime supplier for high-intensity energy needs, such as industrial proc-essing requirements. These demands would employ the capacity of the existing centralized systems even if they were substantially expanded. Third is the consideration of diversified, low-intensity, de

Fourth is the need to extend our thinking to incorporate the built environment as a part of the energy supply industry. It captures and generates energy as well as consuming it; thus,

COULD SUCH A PHILOSOPHY BE MADE TO WORK? The could such a PHILOSOPHY BE MADE TO WORK? The principal constraints to this philosophy are conceptual, attitudinal, institutional, and political. They are neither technical nor eco-nomic— if the economics are optimized in a total system con-text. For example, we are readily and even frantically investing increasing amounts to accelerate the development of atomic and nuclear power, while ignoring the site-generating, low-intensity, decentralized capabilities of small solar collectors in buildings. Goodmitabled Capabilities of small sour collectors in buildings. If we change our manner of conceptualizing the proper "energy system," then we have a proven technology, in a more advanced state than nuclear technology, which would, if properly pursued, give as much equivalent energy as nuclear technology is expected to provide within the next 20 or 30 years—and it could start now.

G. AN ACTION PLAN

There are a number of actions that should be launched without

The new AIA Energy Steering Committee should take the initiative to become a focal point for coordinative leadership in developing and monitoring a national strategy for energy conservation in the built environment. It should be supported by an

vation in the built environment. It should be supported by an adequate capability for strategic policy research and assistance, it should not engage in operational research (see Figure 15).

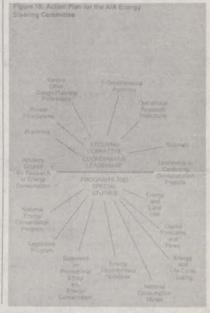
2. The committee should establish an Advisory Council on Research in Energy Conservation to provide annual evaluations of needed research.

3. The following special programs should be developed under the auspices of the Steering Committee until they are sufficiently defined to permit a clear decision as to the appropriate institutional setting for continuing operation: tional setting for continuing operation

- a. The development of a National Program for Energy Conservation in Buildings.
 b. A program for legislative evaluation and assistance
- C. A program for the development of an "Energy Opportunities Notebook."

 d. A program for a National Model of Energy Consumption in
- Buildings.
- a. A program for leadership to catalyze innovative demonstra-
- tion projects.

 f. A program for evaluating relationships between energy and land-use patterns.
 - 4. The following special studies should also be undertaken:



a. A statement on professional ethics and energy conservation. A statement to the profession on special capital-flow forecasts and analyses

c. A statement to the profession on special analyses of energy conservation alternatives and life-cycle costing. Now, let's define each of these actions

Now, let's deline each of these actions.

THE STEERING COMMITTEE: The new AIA Energy Steering
Committee should be organized to provide unusual flexibility at
least for the next year or so, until more definitive institutional procedures can be developed. Consideration should be given to
having the committee include individuals from other disciplines
within the community of professionals concerned with creating the built environment. In addition to the normal support provided by the AIA staff, the committee should have adequate policy-research capability to support its activities.

Present and proposed policies need to be evaluated constantly in the changing dynamics of the strategic context—but they seldom are initial activities of such an effort would extend the work begun here and transform it into material usable at the policy-evaluation level. An annual report on national energy policy-evaluation level. An annual report on national energy strategies—rhotrical, operational, and leasible alternatives— would be a useful and constructive document for policymakers working in the public and private sectors. Such a report can be compared to the present reports on the federal budget issued by

AN ADVISORY COUNCIL ON RESEARCH IN ENERGY CON-AN ADVISORY COUNCIL ON RESEARCH IN ENERGY CON-SERVATION: Conservation programs will need an informal ad-vocacy and advisory group if they are to become politically successful in winning some degree of budgetary priority. Funding agencies and legislative officials need a resource offering inte-grated, coherent advice so that federal efforts in this field can achieve their maximum yield for the monies expended.

The council could be assigned the task of preparing an annual report on energy conservation research and making recommendareport on energy conservation research and making recommenda-tions for a research agenda as the vehicle for publicizing the AIA's concern with this field Liaison with other professional societies, and organizations could complement the advisory role of the committee and greatly increase its utility as an adviser to the federal structure. This council could go far in providing the nation with an effective, dynamic, and better coordinated research effort and thus encourage the strategy of energy conservation in

A NATIONAL PROGRAM OF ENERGY CONSERVATION IN BUILDINGS: This report has presented a variety of arguments for immediate, vigorous efforts to formulate an operational strategy for energy conservation. These efforts can be pursued on three

The AIA could resolve at its next convention that such a strategy should be pursued, and offer to provide guidance to the strategy by providing an umbrella for an aliance of building-re-lated professions interested in energy conservation.

2. The AIA could develop a joint statement with several other

nal associations

The AIA could formulate a general resolution calling on

Congress, the executive branch, state and local officials, various professional organizations, and other interested parties to join in the formulation and promotion of a strategy of energy conserva-tion. A simultaneous effort would be made to encourage the genand it amunant-out enter wood be made to encourage the gen-eral public to support energy conservation in a political sense as well as in its private decision-making. If discussions were undertaken immediately, at least a general resolution could be offered at the next AIA convention. Actions

resolution could be othered at the next Ask convention, actions of this type will be necessary if the energy conservation strategy to to receive the political and budgetary attention enjoyed by the petroleum, gas, coal, or nuclear energy industries. Of course these resolutions would require sustained staff work to develop the

LEGISLATIVE EVALUATION AND ASSISTANCE: The groundswell of local and state legislation that appears to be underway should be guided to a positive role. A priority effort should be should be guided to a positive role. A priority effort should be launched to develop a framework within which legislative proposals could be evaluated. In addition, consideration should be given to the feasibility of a "Model Packet" for "Legislation for Energy Conservation in Buildings" appropriate for passage at local and state twels—and perhaps at the national level. This initial effort should be followed by a sustained "legislative clearing house" which would monitor the various activities around the nation and update the recommended packets. Only by such positive indigenting is a tilized, that the huisting professions can lead the leadership is it likely that the building professions can lead rather than react. Only through such leadership is it likely that we will minimize the number of mistakes that we institutionalize.

AN ENERGY OPPORTUNITIES NOTEBOOK: There is need for a procedure to collect and evaluate all of the "energy savers" that have been and will be suggested. Reported data should include a brief but complete technical description of what was done, adequate detail as to the critical variables concerned, data as to the probable cost with comparisons of alternative systems, includ-

the probable cost with comparisons of alternative systems, including the nonenergy saver systems and estimated data on the expected operating cost differential for each of the alternatives expected operating cost differential for each of the alternatives. An information exchange center would receive these reports and constantly seek a complete inventory of energy conservation practices. Simple reporting forms should be designed and various incentives could be developed to encourage practitioners to report their ideas. The reporting could be simplified by having a toll-free telephone number where the information could be taken informatily, the processing and evaluation could then take place. Credit should always be given to the reporting individual. Those ideas regarded as appropriate for inclusion could be written up and inserted into notebooks. The notebooks could be distributed through a subscription service with a charge to help defray the costs of the clearinghouse operation. However, stable funding should be assured through some form of subelly for several years.

The fooseless "Opportunities Notebook" should be regarded as

should be assured irrough some form of succesty for several years.

The flooseleat "Opportunities Notebooks" should be regarded as just that. Efforts to convert these ideas and opportunities to building codes or other forms of legislation, or any forms of rigid institutionalization, would be premature and should be

DEVELOPMENT OF A NATIONAL MODEL OF ENERGY CON-

SUMPTION IN BUILDINGS: The current data base used for national policy decisions has some serious shortcomings. There is a need for more precise modeling capabilities with respect to particular energy-related actions. For example, solar alternatives may yield the highest returns in some sections of the country or in some types of buildings while other processes may serve better elsewhere. A basic policy evaluation model of energy consumption patterns and opportunities should be constructed. The model could be developed by the modified sampling type of approach used extensively in other areas of policy evaluation.

used extensively in other areas of policy evaluation.

The first step is to derive a scientific sample of a manageable set of representative buildings strategically located throughout the nation. This would give a legitimate profile from which to make national straintest. Conceivably, a definitive number of building types can be determined which will account for a substantial percentage (say 85 percent) of the buildings within the United States. An energy monitoring instrumentation system, appropriate to yield the energy flow data needed, would be designed. These instruments would be installed in a set of buildings fitting the representative national profile, properly taking note of functional, regional, and other variations. The system would be put into operation for a sufficient period to establish the necessary base-line data. Then various interventions would be tested in the form of energy conservation techniques retrofitted to existing buildings.

Controlled experimentation would then be possible, achieving comparative analyses of the respective advantages and full consequence of various combinations of energy-conserving processes and devices retrolleted to varying conditions.

This national energy monitoring system would provide more precise information on which to construct policy initiatives, various incentives, and a system of tailored priorities to optimize the energy saving strategy in retrolitting existing building inventory.

The data would also be useful in design alternatives for future buildings. Should this system be developed, it would become a prime source of the material to be put into the "Energy Conservation Congolius Notebook" discussed presidents.

LEADERSHIP IN CATALYZING INNOVATIVE DEMONSTRATION PROJECTS: The most powerful persuader in our economic
and political system is to do something that works. A variety of
combinations might be tried. Natural gas and electric companies
could be asked to join hardware suppliers, developers, and building designers in a consortium to develop, and install energy conservation packages including solar and other forms of on-site
generation. Reserve capacity of the regular energy system would
provide a fallback for these systems. Perhaps the energy-generating equipment on alte could be owned by the utility which
would then self the energy through meters at a preferential rate.
This organization of service could retain an integrated maintenance and management responsibility and provide the utilities with a
new energy-generating and conversion strategy. This strategy
would also allow a ready means for the utility to optimize its
capital investments consistent with an optimum national energy
strategy. Meanwhile, the utility tage struture could be used as the

means to raise the necessary capital. Such a system would avoid the difficulties posed by the concern for initial construction costs. Thus, the marketing problem of capital-intensive on-site energy conservation packages could be shifted from a market that resists it (owners) to a market that seeks it (diffities), making our present systems of economic and technical incentives work for, rather than against, the energy conservation strategy.

Such a series of experimental demonstrations is more than an illustration of hardware capability. Rather, it is a demonstration that institutional rigidities and the other nontechnological barriers to the strategy can be overcome. Such projects should be set footh as business opportunities, not government subsidy programs. The design and management costs might well be partially underwritten from current research authorizations. Special subsidies of the pilot projects may be in order also, but the ultimate objective should be absorption as a normal, economically advantageous business opportunity.

THE RELATIONSHIPS OF ENERGY AND LAND-USE PATTERNS: The planning/design professions have impacts on energy use or conservation that stretch far beyond buildings themselves. The spatial layout of the national land-use patterns, and of local land-use patterns, are prime determinants of energy demands such as transportation. At the other end of the specitum, it is generally conceded that townhouses clustered logether use less energy than the same amount of living space built on detached single-residence lots.

angle-residence loss.

A commonsense viswpoint might be that the more dense the development, the more energy efficient it would be. But there are a variety of other dimensions to the question. If we were successful in developing the "self-sufficiency" concepts to include recycling or ecologically closed systems insofar as possible, then the benefits of centralization might be offset, and a richer array of qualifative options retained.

the benefits of bentinazation might be obset, and a noise any of qualifative options retained. Investments in land with high development potential may be threatened because, as interest rates rise and development limetables extend, substantial losses can occur due to the increased holding costs and the extended time the holding costs will have to be borne. In some instances, the intended developmental patterns are not likely to be realized.

There is a cluster of escential research projects that should be

There is a cluster of essential research projects that should be formulated in order to build the necessary information for choosing more reasonable strategic focational choices.

A STATEMENT ON PROFESSIONAL ETHICS AND EMERGY CONSERVATION: Architects, like others in the building design professions, do not have complete autonomy in what they decide, Builders, lenders, public officialis, and ultimate users all have a profound impact upon what can be done. However, a statement of energy ethics could be developed and adopted as a principle to be employed by practitioners to the degree possible. For example, it could become routine procedure to provide a client builder with a complete evaluation of the economic and other factors associated with the various energy conservation measures that he should employ. The principles of life-cycle costing should be brought to bear, in order to show the economic payout

of various increased capital costs. In addition, the probability of the confined availability of the various fuels might be included, although this information would require a rather extensive and constant research effort. The means of carrying out the ethical charge would essentially be provided through the "Opportunities" Notebook." As a minimum, the professional architect should be expected to advise his client on the possibilities considered appropriate from the list of opportunities appearing in the note-book. He could, of course, amplify that list based on his own

viedge and judgment.
STATEMENT TO THE PROFESSION ON CAPITAL-FLOW A STATEMENT TO THE PROFESSION ON CAPITAL-FLOW FORECASTS AND ANALYSES; A variety of studies and estimates suggests that we are entering a period in which there will be increasing competition for scarce capital. Thus it cannot be safely assumed that the energy-generating demands can be met, because they may encounter a capital shortage that cannot necessarily be overcome by increasing the interest rates. The problem goes beyond national boundaries. Capital currently returns interest rates of 14 percent or more in some countries. The rapidly growing international capital market, supplemented by the emerging network of multinational corporations, makes possible an eco-nomic decision-making structure unlike those which have traditionally prevailed

The inflationary price implications of scarce critical materials are already evident even in the present stage of the energy probare arready evident even in the present stage of the energy prob-lem. Groups not directly involved could conduct analyses of the economic implications of the energy situation. Among the main interests to the building design professional would be the implica-tion for building costs and indeed for building projects themselves if capital is either short or more expensive. This capital limitation could become most colling by the acchierchal expension.

A STATEMENT TO THE PROFESSION ON SPECIAL ANALYSES OF ENERGY CONSERVATION ALTERNATIVES AND LIFE-SES OF ENERGY CONSERVATION ALTERNATIVES AND LIFE-CYCLE COSTING: The implications of life-cycle cooling are well known indications are that energy conservation in building is an economically vable alternative, and will become increasingly so as energy costs rise. In terms of an energy economy, it has been estimated, for example, that every Blu required in the construc-tion of a building is matched by another Blu during each year of ison or a building is matched by another still during each year of its life. Thus, in terms of energy conservation, front-end invest-ments get returns of 30, 40, 50, or even 100 to 1. Of course this analysis does not necessarily translate into similar economic payoffs. It does, however, suggest the possibilities that could be tapped if the economic consideration of alternative building con-struction included energy conservation versus nonenergy con-

servation techniques.

The methodology for such studies in the energy area is still quite crude, but well worth immediate exploration.

IN CONCLUSION:

I recognize that these actions are broad, challenging, and diffi-cult to attain. But the energy problem, like the environmental problem, refuses to comply with our human and institutional de-sires to divide things into narrowly defined and easily managed

Leadership aimed at resolving the energy problem must con sider this broad perspective of energy and respond in ways that match its magnitude and complexity, rather than relying solely on traditional approaches

Who more than architects might be expected to meet this challenge?

Leo A. Daty, FAIA Chairman, AIA Task Force on Energy Conservation

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(Fig. 5 presents data from p. 15 of this report.)

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A NATION
OF ENERGY
EFFICIENT
BUILDINGS
BY 1990
THE AMERICAN
INSTITUTE OF
ARCHITECTS

ENERGY STEERING COMMITTEE

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INTRODUCTION

BACKGROUND
In the autumn of 1972 the American Institute of Architects began to explore the retationships between energy and the built environment and to determine how the design professions can contribute to solving the nation's energy problem. This is the second major report to emanate from this continuing effort. The first report, Energy and the Built Environment: A Gap in Current Strategies, established the framework for subsequent AIA energy efforts. The report analyzed the forms of energy and energy systems, defined energy efficient buildings, quantified the potential of energy savings offered by energy efficient buildings, and proposed an action plan for specific efforts and programs required for full implementation of an energy efficient buildings trategy.

grams required for full implementation of an energy efficient buildings strategy.

Two major energy systems were conceptualized. Using an economic analogy, the first energy system was labeled "current income," referring to natural regenerative sources such as solar, wind, and hydro power. The second, labeled "capital energy," refers to finite sources which, once used, are lost forever. Capital energy includes such sources as coal, gas, oil and uranium. The report observes that within the past 100 years man's energy systems have shifted from those dominated by nature's current income accounts to systems dominated by nature's capital accounts. counts

Energy conservation (or efficiency) in buildings is defined in the

- 1. The reduction of demand by eliminating the waste of energy
- in buildings.

 2. The adoption to the degree feasible of on-site utiliza-

tion of the natural "current income" energy flowing around and in the buildings to replace traditional centralized energy

and in the buildings to replace traditional centralized energy production systems based upon finite sources. During 1972 and 1973 a variety of studies began to appear which estimated the amount by which energy demand could be reduced if buildings were designed and constructed to be enreduced if buildings were designed and constructed to be en-ergy efficient. The estimates varied considerably as a function of the various components they included and differing judgments of technical and economic feasibility. They ranged from 10% to 50% for retrofitted buildings and up to 80% for new buildings initially designed to be energy efficient. At the time, it was con-cluded that 30% and 60% were reasonable averages of the conservation potentials in old and new buildings, respectively. Studies since have reinforced these estimates to the point they are now increasingly regarded as very conservative.

The true aignificance of the potential offered by these energy efficient buildings comes into focus when these estimates are cast into a national perspective and compared to the productio capacines or the indefined energy supply industries. If we adopted a high-priority national program emphasizing energy efficient buildings, we could by 1990 be saving the equivalent of more than 12.5 million barrels of petroleum per-day. This is about as much energy as the projected 1990 production capacity of any one of the prime energy systems: domestic oil, nuclear energy, domestic and imported natural gas, or coal.

Present policies will not realize these potentials. The bas Present policies will not realize those potentials. The base too son that opportunity may be lost is not a lack of technological capacity, but rather the existence of conceptual and institutional rigidities. We are now investing vast quantities of increasingly scarce capital resources in strategies which have less poten-tial, less certainty and longer-delayed payoffs than the proposed alternative strategy emphasizing a national program for energy efficient buildings.

OVERVIEW OF THIS SECOND REPORT

This second report Energy and the Built Environment: A Nation of Energy Efficient Buildings by 1990 outlines a national program to achieve the potentials of energy efficient buildings. It shows how the program can be made economically, financially, and administratively feasible, and presents a series of recommendations for immediate action

dations for immediate action.

Highlights of this report are as follows:
—In order to supply the energy equivalent of 12.5 million barrels of oil per day by 1990, a capital investment of \$415 billion will be required in traditional centralized energy supply systems.
—The cumulative cost to the consumer to buy this wasted energy will range between \$892 billion and \$1.499 billion.

To make all buildings approximational by 1990 will remote

will range between \$992 billion and \$1,499 billion.

—To make all buildings energy efficient by 1990 will require capital investments of from \$729 billion to \$1,460 billion. However, the net additional capital requirement, considering the capital investment of \$415 billion required to generate this "saved energy", is from \$314 billion to \$1,045 billion.

—The capital investment in energy efficient buildings will pro-duce both energy and dollar savings. The consumer costs men tioned above become the source of the cash flow required to

the alternative investment in energy efficient buildings. Analyses allow that applying these amounts will recoup the investments for energy efficient buildings within 10 to 15 years. This permiss the same capital to be used twice within the 30- to 40-year payback period which is normal for traditional centralized energy plants.

period which is normal for traditional centralized energy plants.

—In an emerging period of scince and expensive capital this more efficient use of dollars becomes an important policy consideration. Projections show that there may be a capital shortage as high as \$315 billion between 1974 and 1865.

—The proposed stategy for energy conservative buildings is a valuable component in reducing this "capital crunch" as well as in contributing to the solution of the national energy problem.

—A practical approach to the administrative structures for implementation is described. The administrative structures for implementation is described to entail a minimum of dislocation with substantial social and economic side effects beyond the direct contributions to the energy problem. contributions to the energy problem.

The key recommendations of this report are:

he key recommendations of this report are:

The nation - should proceed immediately toward a high
priority national program to make the nation's building inventory energy efficient by 1990. This program should be
pursued at a rate which will annually yield nearly one
million additional barrels of petroleum per day in energy
savings, reaching the full potential of reduced energy requirements equivalent to more than 12 million barrels of
petroleum per day by 1990.

The basic concepts outlined in this report should be developed into operational plans for the conduct of at least
six national demonstrations of sufficient scale and diversity,
to field test the entire concept. These tests should be gotten
underway in 1975.

underway in 1975

underway in 1970.

The AIA, through its Energy Steering Committee, the committee staff and the policy research consultant, and with the cooperation of the AIA Research Corporation, will offer coordinative leadership in the effort.

The other building design professions and associations, the President of the United States, the Departments and Agen-cies of the Federal Government, Governors and State Governments, and corporations within the private sector are en-couraged to lend their participation and full support to the realization of this vital national opportunity.

These ambilious objectives can be achieved only if the nation's

These architlous objectives can be achieved only if the nation's leaders provide the support required to sustain the effort. Government agencies, business organizations, academic institutions and relited professional associations will soon be invited to join the American Institute of Architects in assigning top priority to the development of detailed plans for launching a series of substantial demonstration projects to initiate the program for A Nation of Energy Efficient Buildings by 1990.

We believe that a careful study of this report will lead others to share both our conclusions and our enthusiasm, and thus to lend the full support and leadership which the opportunity calls for and which the nation described.

to learn the tuti support and readership which the opportunity calls for and which the nation deserves.

Details of these conclusions, of the proposed concept for administratively structuring the approach, and of the specific actions we recommend are contained in the following pages.

EVALUATING THE CAPITAL ISSUES OF A NATIONAL PROGRAM FOR ENERGY EFFICIENT BUILDINGS

EXTENSIVE CAPITAL WILL BE REQUIRED TO SUPPLY WASTED ENERGY

In the first report, referenced previously, it was estimated that if all the nation's buildings could be made energy efficient by 1990 an the hallon's Sullivings could be made energy elected by 1990 through retrofiting of buildings and designing energy efficient med buildings, the equivalent of 12.5 million barrels of petroleum per day would be saved. Figure 1 shows the capital required to generate this amount of energy. Column 1 shows the estimated breakdown of the sources of the savings as delivered to the building; i.e., if gas or oil is used to produce electricity, those quantities are shown under electricity.

Figure 1: Estimated Capital Required to Produce Wasted Energy for Non-energy Efficient Building Operations

	Estimated Savings Potential In MBPE/PD 1 1990	Estimated Capital Req. in 1970 \$ Per MBPE/PD	Gross Capital to Generate Potential Savings in Traditional Supply System in 1970 \$	Gross Capital in Ourrent \$	
Electricity.	7.0	\$17.98	\$125.38	\$293.9B	
Gas	3.9	11.18	43.38	101.6B	
Oll	1.6	5.28	8.38	19.5B	
	12.5		\$176.98	\$415 B	

With use of buildings retrofitted or built for energy efficience. Energy equivalent of a million barrels of petroleum per day

The second column reflects a rough estimate of the capital re-The second column reflects a rough estimate of the capital requirements in 1970 dollars to produce one million barrels of petroleum equivalent per day. These estimates are based upon National Petroleum Council data and were derived by dividing the projected capital requirements for, each of the fuel systems (electricity, gas and oil) to 1985 (expressed in 1970 dollars) by the net increase in output for each system. Kilowatt hours of electricity, therms of gas and barrels of oil were converted to millions of barrels of petroleum equivalent per day. The net result is an estimated \$17.9 billion for referrical facilities, \$1.1.1 billion for natural gas facilities and \$5.2 billion for oil refinery and pipeline facilities.

and pipeline facilities.

In its over-simplified approach to the calculations must be taken as only a crude estimate. More refined models are available for rendering these estimates with greater precision. For example, models used by the Office of Economics of the Federal Power Commission provide sophisticated estimates accommodating projected effects of differing peak loads, ratio of fossil fuel to Auclear electrical generating plants and a range of other relevant parameters requiring more expectically defined, assumptions. However, estimates conmore specifically defined assumptions. However, estimates con

tained in this report appear reasonably close to those sophisticated calculations which result from specifying the plant mix and load factors in more detail. The range of error is not algnificant in terms of the logic and feasibility of the proposed concept, and much more refined calculating techniques would not appear to change the basic comparisons or conclusions.

The third column of Figure 1 is simply a multiple of the first two columns and shows that about \$177 billion of investment in 1970 columns and shows that about \$177 billion of investment in 1970 dollars will be required to produce energy which present building design will waste. However, since these investments will be incurred not in 1970 dollars, but in dollars current for the year of investment, the fourth column converts the capital requirements to current dollars. These estimates assume an even rate of investment beginning in 1973 and continuing through 1987 (a fifteen year investment package). They also assume an average inflation rate of 7.85%, the actual average rate for non-residential construction for the past six years. Thus, the estimated actual current year cumulative capital investments accounts. tal investments required to generate energy that could be con-served are approximately \$415 billion.

EXTENSIVE FUNDS WILL ALSO BE REQUIRED TO BUY THIS WASTED ENERGY

That we are moving from an era of abundant, cheap energy into a new era of more expensive and possibly scarce energy is now a



well known cliche. The consumer expenditure dollars required to buy the energy which will be wasted through non-energy efficient buildings will be between \$892 billion and \$1,499 billion for the 15

year period.

These estimates of consumer cost assume, as was the case in the investment estimates, that the energy savings (or reduced waste) could accrue at ar even rate of 179, per year until the level of 12.5 million barrels of petroleum equivalent per day is reached. The estimates are also based upon the five ratios of electricity, gas and oil reflected in Figure 1. Average annual increases in cost are estimated at 10% and 15%. These cost increases appear quite reasonable when one considers that they could result from any combination of inflation and real cost increases. These capital and consumer costs of waste energy are depicted graphically in Figure 1.

HOW MUCH CAPITAL MIGHT BE REQUIRED TO HAVE ENERGY EFFICIENT BUILDINGS BY 1990?

Under some conditions there is considerable promise that energy efficient buildings can be designed with fittle increase in cost over traditional construction. In other cases, however, it seems clear that energy efficient construction will require additional cost. Figure 3 shows a range of estimates equal to 10%, 15% and 20% of normal construction costs.

Figure 3: Estimated Gross Capital Required for

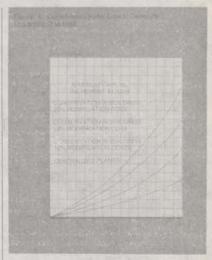
Projected New Building	@ 10% Increment			@ 20% Increment	
Construction: 1973-1987 \$3.461B Retrofitting Existing Stock	\$346B 383B	\$	519B 574B	5	692B 768B
Total Gross Capital Required	\$7298	\$1	,093B	\$1	.460B

The "normal" new building costs of \$3,461 billion are a projection of the cumulative costs of new construction using the last six years as a base period. During these years the value of new construction (including inflation) has increased at an average of 11% per year. The estimates of the cost of refrofitting the existing building stock are based upon the estimated value of all structures as reflected in the national economic accounts. Since these accounts contain data only through 1968, we have projected the 1960-1968 base years to 1972.

The third line of Figure 3 shows the gross capital requirements for a 15-year strategy which assumes that all new buildings would be energy efficient and that all existing buildings would be convotted at an even rate of 7% per year. Separate inflation rates of 5.6% for residential and 7.8% for non-residential construction were used. These are the actual rates experienced over the past six years.

WHAT ARE THE ADDITIONAL CAPITAL REQUIREMENTS NECESSARY TO IMPLEMENT THE AIA STRATEGY?

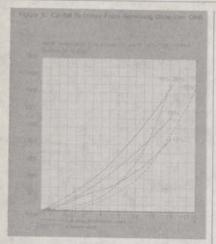
In the preceding paragraphs we have estimated the amount of capital required to produce potentially wasted energy in inefficient buildings and the gross capital requirements for implementation of



the AlA strategy. Since the basic issue involves a fundamental nabonal decision of whether to produce energy for waste or whether to utilize energy efficiently, there is a legitimate trade-off of capital involved. This point deserves special emphasis. The decision is not whether to modify functional demand or behavior or level of comfort; rather, it is whether to invest capital to waste energy or to utilize that same capital to conserve energy. Figure 4 shows the net additional capital required cumulatively for a 15-year strategy to have a nation of energy efficient buildings by 1990. This net capital increment ranges from \$314 billion to \$1,045 billion.

WHAT IS THE COMPARATIVE EFFICIENCY OF THE CAPITAL INVESTMENT UNDER EACH STRATEGY?

Figure 5: converts the previously estimated cost to the consumer of wasted energy into a cash value derived from investment in energy efficient buildings. The value of energy saved is the same for each level of investment costs. The number of years required to recover the entire gross capital investment in energy efficient buildings is shown for all six basic accenarios. The most optimistic estimate would give an average yield of 13.7% on total investment and would recover the total investment within ten years. The



most pessimistic estimate would yield 4.1% per year and re-cover the total investment within 18 years.

At first glance it would seem that this strategy requires more net capital than would be required to generate energy for waste. How-ever, this is not the case. The average time required to recoup the \$415 billion invested in traditional energy systems would be 30 years. Because of the savings generated by the AIA strategy, the comparable recovery period would be approximately 15 years. This would permit utilization of the same capital twice within the same period. within the same period.

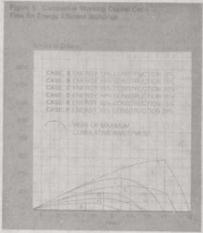
HOW MUCH WORKING CAPITAL WOULD BE REQUIRED TO REALIZE THE AIA STRATEGY?

Figure 6 shows the estimated amount of net working capital that would have to be invested in each year of the 15-year program if

would have to be invested in each year of the 15-year program in the Ald stategy is to be launched.

Each line shows the cumulative year by year working capital flow for each of the six scenarios combining three levels of incremental capital costs and two levels of increased energy costs.

Under the most optimistic of the scenarios, i.e., capital increments of only 10% with energy cost increases of only 10%, the net first year investment in 1973 dollars would be \$22.6 billion.



This net annual investment would fall each year until within the eighth year no additional investment would be required.

By this eighth year, the cumulative investment would be \$111 billion. Once the fund becomes self-sustaining in the eighth year, it is repaid in full within five years. Hence, eight years into the program the fund has become fully self-sustaining. In the thirteenth year it will have been fully recovered. If prices of energy leveled off after the fifteenth year, the investment would be repaid about every eighteen months until the building was replaced or until some of the basic on-site generating capacity required replacement. Thus, the total working capital requirements under this scenario would be \$111 billion.

A quick study of the chart shows working capital requirements under each of the six basic scenarios. The range is from \$36 billion to \$358 billion. Even under the most pessimistic scenario the fund becomes self-sustaining in the fifteenth year and is completely recouped within the eighteenth year. It then repays listed about every two and one-half years thereafter.

ADDING SHORT TERM INCENTIVES

Figures 7A and 7B show effects upon payout times and cash flow prough the system under each of the six basic sets of assumptions

if we permit a 5% or a 10% return on depreciated investment (at 335% per year) to accrue to the system owner and a return of 10% of asvings to accrue to the system were rand a return of 10% of asvings to accrue to the system use. Even if these significant amounts flow out of the system in the form of current returns, only in the worst situation—in which incremental capital requirements are 20%, with cash savings of only 10%—will the payback period extend beyond the presently acceptable 30 years for long-term building and energy plant investments. In this "worst" case, the payback period would be about 34 years. If we reduce the return on fixed investment to 565—still well above the present rate allowed for repayment of utility investments—we would reduce the payback period even in this instance to 26 years. Figure 7B shows the shorter payback periods for all six cases with this reduced return on fixed investments.

ments.

Cipitating costs of the two basic strategies cannot be compared.

One because there are inadequate empirical data from which to determine costs of mentalning the kinds of new energy systems envisioned. We believe, however, that the energy efficient strategy.

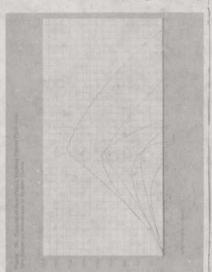
will also require lower operating costs. This would further increase its comparative attraction. The rationale for this judgment about operating costs will become clearer later as the components of energy efficient building systems are discussed.

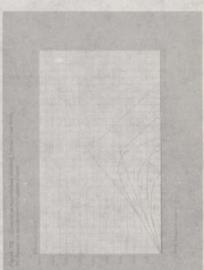
CAPITAL FOR ENERGY EFFICIENT BUILDINGS IS ALSO A WISE MACROECONOMIC STRATEGY

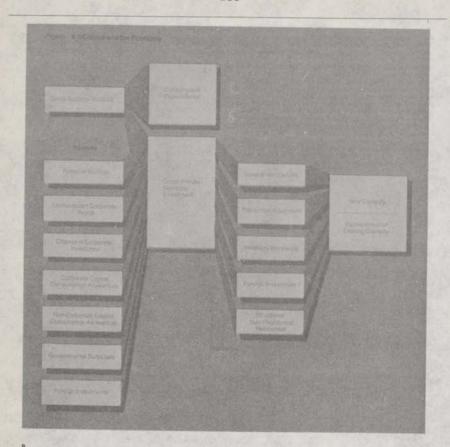
Is ALSO A WISE MACROECONOMIC STRATEGY in the preceding paragraphs we have shown the economic efficiency of capital invested in energy efficient buildings. It was shown that the strategy is economically self-sustaining and more afficient as a use of capital at the microeconomic level. This section casts the two strategies into relief against the backdrop of an impending capital shortage within the U.S. economy, investment in energy efficient buildings is therefore shown also to be a wise-microeconomic choice.

macroeconómic choice.

Meeting the recede of the nation's residential and nonresidential buildings depends as much upon an adequate supply of capital at reasonable interest rates as it does upon adequate lumber, blroks, moritar and skilled tabor. In terms of the national economic







accounts, building activities fall within the context of gross private domestic investment in this sense, they service capital dependent markets and they are capital dependent industries.

Of course, buildings and related design activities are not the only consumers of capital. They must compete with other needs for

their share of capital. The national econor expenditures: consumption and capital investment. (See Figure It is readily apparent that capital comes from the "surplus," i.e., t "awings." of our economic productivity which is not required for consumption and which can be reinvested into economic and social development and growth: These "axvings" create a capital pool which is dispersed largely into five basic categories; governmental delicits, production equipment, inventory increases, for-eign investments and structures. These capital expenditures may represent increased capacity or replacement of existing capacity.

will be sufficien will be authicited asynigs to provide a capital reservoir adequate for capital needs. If capital can be expected to be plentiful, then the efficiency with which capital is used is not overly important from a national policy standpoint, If, on the other hand, the supply of domestic investment is limited, and if that shortage cannot be filled by a locirable increase in interest rates or other financial policies, then the efficiency with which capital is used becomes critical. Also critical is whether we can make a trade-off between consumption expenditures on behalf of capital expenditures as a means of providing needed capital investments without depriving ourselves of needed consumption. The AIA Strategy for Energy Efficient Buildings offers the equivalent of a trade-off of unnecessary consumption costs required to purchase wasted energy for capital costs which would permit that energy to be say

LONG TERM SUPPLY/DEMAND PICTURE FOR CAPITAL

Many economists maintain, at least theoretically, that the supply of capital will always be equal to the demand it interest rates are nomic models generally tend to show the supply and demand for capital to be in balance. In such cases, the capital projections are more of a statement of the anticipated supply than of the antici-

pated demand.

Other kinds of forecasting, such as those used for energy, em-sloy different approaches. They assume demand to be a realistic expression of needs and project anticipated demand first. They then seek to bring the supply capacity into line with the projected demand. These energy forecasts are discussed in greater depth as the cylonial apport adjacanced above.

in the original report referenced above.
Our original intention was to use supply/demand projections made by economic specialists and to utilize them as a contextual baseline for evaluating whether the nation will face a capital shortbaseline for evaluating whether the nation will table a capital shortage. We conducted a survey of capital forecasts made by economists, universities, thade associations, corporations, banks and
federal agencies, but found that these studies were inadequate for
our needs. They variously dealt with specific needs of an industry,
or did not project beyond the next five years, or used methods that
sorced a balance between supply and demand, or were developed
serious the supply of the supply of the supply and demand, or were developed
serious the supply and demand, or were developed

before the massive energy related capital demands had been

which sought to low a capital demand from the standpoint of the needs of the economy and capital supply from the standpoint of the savings potential. Where estimates relating to a particular indus-try's needs were available, they were used. Where such data did not exist, we calculated a historic trend of the capital investment-to-sales ratios, projected these ratios against the projected sales of the industry compiled by the Department of Commerce, and so derived the estimated capital requirements for 1980 and 1985. The years between were assumed to accumulate at even average growth rates. In a few instances the capital growth rates were obviously not sustainable and we modified these projections to a ower, more plausible rate of growth.

lower, more plausible rate of growth;
As a further check we also made a series of foreclasts based upon past-trends (using a 28-year and an 8-year baseline) and upon the projected capital investment per employee in the labor force. These calculations, together with selected estimates made by other organizations, are shown in Figures 9 and 10. As we were completing our analysis, the New York Stock Exchange published its projections developed with essentially the same approach. The two estimates, derived independently and using somewhat offerent methods, are in surprisingly observagreement on a projected capital shortage.

projected capital shortage. Figure 9 shows the estimates for supply and demand of capital from 1950 to 1985. Actual data were used through 1973.

The historic experience shows no divergence between supply

and demand because the economic accounting systems have no way of defermining unfilled demand or need. The supply projections are shown as shaded areas in the graph. Each of the four major sources of savings within the economy was projected separately by using average growth rates over the past 23 years and the past eight years. The 23-year experience base gives the lower figure and is depicted in the deeper tone. The eightgives we lower iguite and is depicted in the deeper tone. The aignt-year experience base would yield slightly higher savings. These increments are added in the lighter hone. Note that a composite negative supply is estimated from the combination of the four minor sources of savings; net surplus (delicit) of the tederal govern-ment, not surplus (delicit) of focal povernments, net imports of capital, and changes in corporate inventiones. The solid lines along the top of the shaded areas represent the cumulative projected supply of capital

These supply lines could also be regarded as projected demand for capital, if we project demand on the basis of past gross private domestic investment using the same base periods of 23 years and

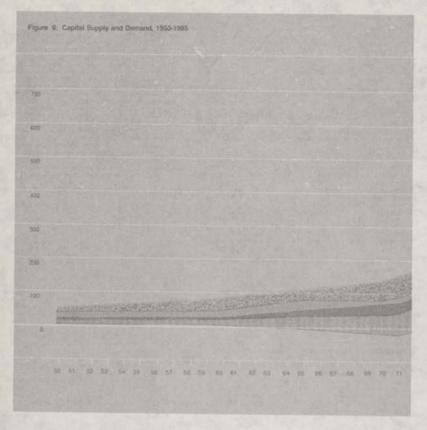
The solid line labeled BLS represents the supply/demand fore-

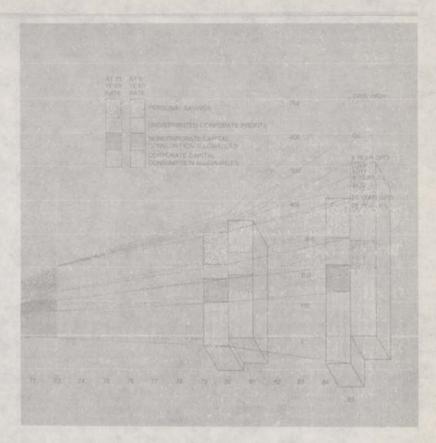
The solid line labeled BLS represents the supply/demand fore-cast of the Bureau of Labo. Statistics.

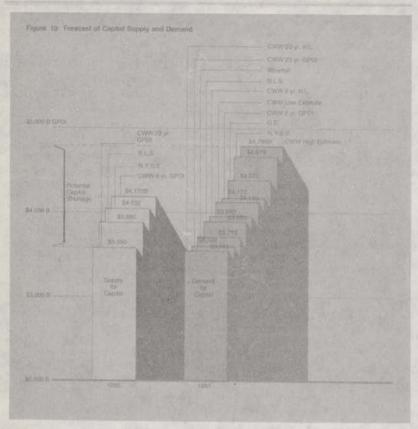
The two solid lines labeled K/L are estimates of demand based upon the relationship of capital investment per individual in the labor force projected from the 23-year and eight-year base periods and multiplied by the Bureau of Labor Statistics' estimate of the number of persons to be in the labeled CE represents the capital demand esti-mates developed by the General Electric Corporation.

The remaining solid lines labeled CEW represent the forer-sate

The remaining solid lines labeled CWW represent the forecasts







developed by Charles W. Williams, Inc., the policy research firm t to the AIA Energy

hich serves as a consultant to the AIA Energy Steering Committee Our judgment is that the top two demand forecasts are the most realistically indicative of future developments. In this sense, we share the New York Stock Exchange's conclusion that the U.S. economy may experience a serio

Note that the percentage of personal savings within the over-l supply of capital becomes higher. This makes the supply projections heavily dependent upon continuity in people's savings habits and a continuation of the trend toward more per ings habits and a continuation of the trend toward more per-sonal income being placed into savings. The assumption that this trend will continue seems especially doubtful in light of what is now being acknowledged as a "long-term" problem of inflation. It remains to be seen what effect this higher inflation rate will have upon personal savings, but the most reasonable assumption is that it will tend to discourage savings. In light of these factors, we would regard the supply estimate as some-

trese factors, we would regard the supply estimate as some-what optimistic.

Figure 10 reflects the cumulative totals of the most significant lines discussed above. Column 1 shows that the various estimates of savings potential or supply equal between \$3.8 frillion and \$4.17. or savings potential or supply equal between 3.5 trillion and 34.17 trillion. The corresponding demand forecasts are shown in the second column, ranging from \$3.545 trillion to \$4.795 trillion. The important implication of these figures is the potential capital shortage highlighted by the horizontal dotted lines. Under the first seven methods of forecasting demand there is no significant gap to be anticipated, however, under the top three demand forecasts, there are significant supply shortages of between billion and \$915 billion (or shortages of about 15% to 20 billion and 3915 oillion (or abortages of about 15% to 20%). If these calculations are even approximately correct, the present capital crunch should be seen as only a forerunner of things to come. The more significant impacts of a shortage of capital will begin to materialize toward the end of this decade and will continue into the next. The picture of delayed impact is especially important in terms of developing policies now which will cially important in term not be regretted later.

not be regretted later.

Of course, it can be argued that even if this gap does materialize,
it can be filled by attracting foreign capital. For example, some
maintain that our capital problem can be resolved by negotiating
with the oil producing countries to invest their surpluses. In the U.S. economy, Imagine the situation which would result: A small bloc of cooperating countries which may control more than half of the international monetary liquidity in the next decade would be in a position not only to affect our social and economic wellbeing by controlling supplies and prices of petroleum but also to deal a crippling blow to our economy by depriving it of needed capital. The gravity of such a scenario needs no elaboration. Even more important is the fact that petroleum is only the first

even more important is use to that personant is only in the most of a growing number of basic raw materials for which we are becoming increasingly dependent upon imports. Imported capital simply means that interest too, will be flowing out of our economy and thus will contribute to a growing problem in balance of pays

The foregoing analysis suggests that we should, at least to e degree possible, follow a strategy of "Project Independ-

ence" for capital as well as for petroleum or energy supplies. ence for capital as well as for petroleum or energy supplies, In fact, it is reasonable to postulate that if present policies are continued, we will probably have just such a "crisis of capital" sometime during the 1980s. Prudence would seem to indicate that we evaluate our present policies in the context of these possibilities.

Based upon these data and this logic, we reach the following

There will be continuing shortages of capital in absolute terms relative to the needs of the economy. This will create a growing senes of priority battles for increasingly scarce, and possibly more

experaive, capture.

—This affuation probably means continuing high interest rates despite the current discussion of reduction. Such interest rates may go as high as 15% or 16% unless some policy action to place ceilings upon them is taken. It is most likely that at some point, the politics of the matter will produce a demand for a ceiling on

As the amount of capital consumed in depreciation increases, capital for expansion will become increasingly difficult to raise.

—Thus, the efficiency with which we use capital will become in-

reasingly important.

In such a situation, capital for energy plants and distribution systems or for buildings, with a payback period of 20 to 40 years, is likely to be harder hit than capital for other investments with

payback periods of five to ten years.

—Consequently, a "free capital market" for allocating the supply

of capital among competing objectives is not likely to remain politically or socially viable.

politically or accessly viable.

The proposed Strategy for Energy Efficient Buildings is consistent with these new realities of capital, in just the same way as it is consistent with the supply/demand realities of energy. This alternative can be structured to convert consumption expenditures to capital investments.

expenditures to capital investments. If this strategy were implemented immediately, the repayments derived from energy savings could become a valuable source of capital to help underwrite the projected capital shortage just as if becomes more acute. Moraover the impact of the net working capital required under this strategy can be absorbed early in the period of its implementation, making the capital shortage less intense in the years in which it becomes most severe in the larger economy. The importance of this strategy to the overall national economy new propense clear.

The foregoing analysis, which has consistently leaned toward conservatism, is startling even to those of us who have been working with the concept for more than two years.

While we do not wish to dramatize the case, we consider the following conclusions to be fully justified:

—The AIA strategy is a more immediate and more certain contribution to the objectives of Project Independence than other energy alternatives presently proposed.

The AIA strategy is economically self-sustaining at a better rate

of return than is generally expected from long-term investme in construction and in utility or energy systems.

The AIA strategy is realizable with a minimum of dislocation within the present energy systems because it is complementary to

remedying a projected shortage of supply.

The AIA strategy employs capital in the more consumer-oriented

—The AlA strategy employs capital in the more consumer-oriented part of the building industry and will result in needed atmustation of a depressed sector of the economy. This effect will be more equally distributed geographically than would be the case in construction of large centralized energy systems.

—The AlA strategy is a more desirable long-term national energy strategy than other proposed alternatives. Investment of scarce capital to consume, as waste, those scarce resources drawn from nature's capital accounts in not. The 34th billion that will be invested in generating wasted energy supply should therefore be diverted and used to invest in conservation. This alternative uses the same capital in a more rational manner from economic, political and social standpoints.

political and social standpoints.

The AIA strategy is more consistent with the overall economy's e of capital supply/demand

picture of capital supply/demand.

Thus, the strategy for energy efficient buildings should be immediately launched and implemented on a high priority basis with a national objective of realizing 7% of the projected energy savings each year (the equivalent of 875 thousand barrels of petroleum per day) in order to reach the full potential savings, equivalent to 12.5 million barrels of petroleum. per day, by 1990.

TOWARD IMPLEMENTATION

Figure 11 summarizes the entire analysis to this point. i.e., both the first report and the preceding sections of this report. Present building practices and energy concepts result in buildings which depend solely upon some combination of traditional electrical, gas and fuel oil systems. The AA Strategy for energy efficient buildings superimposes two basic types of conservation.

1. Reduction of waste through modified design and construction techniques and through more efficient environmental control systems.

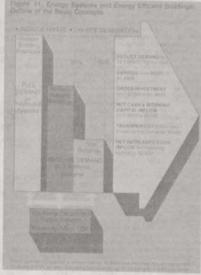
2. Reduction of demand upon fossil-based fuels and centralized

2. Reduction of demand upon fossil-based fuels and centralized supply systems through or-site generation from nature's current income accounts—principally solar and wind.

By following this two-pronged strategy in retrofitting existing buildings, demand upon the traditional energy systems would be decreased by an average of 30%. The adoption of energy efficient building concepts for new buildings would conserve an average of 60%. The traditional supply systems thus will be converted from a total energy supplier to a reserve supplier, providing only such energy as cannot be supplied by on-site generation. Since building operations call exclusively for low intensity egenty, the technique generation call exclusively for low intensity egenty, the technique generation call exclusively for low intensity egenty, the technique generation call exclusively for low intensity egenty, the technique generations call exclusively for low intensity egenty, the technique per supplier of the second control of the second called the second

energy as cannot be supposed by on-site generation, since build-ing operations call exclusively for low intensity energy, the tech-nology now exists for on-site generation of a substantial proportion of the energy needed for operation of buildings.

These concepts, if applied on a national scale, will result in a reduction of demand upon traditional energy sources of more than the equivalent of 12.5 million barriels of petroleum per day by 1990. The cumulative value of the consequent savings will range between



\$892 billion and \$1,499 billion; \$415 billion of this investment can

\$892 billion and \$1,499 billion; \$415 billion of this investment can come from eliminating the requirement for additional centralized plants to generate this potentially wasted energy. If all of the savings were recycled into investments for energy conservation in buildings, decreasing net cash inflow to the working capital funds would result. The total cumulative cash inflow yould be as low as \$86 billion over about eight years or as much as \$568 billion over about eight years or as much as \$568 billion over about there is years. Thus, the energy conservation in buildings strategy may require less net cash inflow than would be needed to finance the \$415 billion in frational plant capacity otherwise required to generate wasted energy. These estimates, as dramatic as they seem, are nevertheless considered to be quite conservative. The actual savings are expected to be higher, the required investments lower and the returns on investment more laworable than we have shown. The conservative nature of the estimated savings is illustrated by a study done by the AIA Research Corporation Energy Conservation Design Guidelines for Office Buildings. This report

deats only with the reduction of demand via elimination of waste. It divides these waste eliminating techniques into two categories. (1) those which utilize only construction techniques such as insulation, double glazing, reduced window area and lower aspect ratio; and (2) those which utilize both construction techniques and optimization of environmental systems such as pumps and tans, cooling, lighting and heating optimization. Using only the first set of techniques, the report estimates that energy consumption in a new office building in New Hampshire could be reduced by about 36%. Using both approaches yields savings in energy of an estimated 60%. Thus, the estimates upon which we have based these policy evaluations are no greater than the estimates which are believed achievable under only the first prong of the conservation strategy—reduction of waste. Conservatively speaking, probably 40% to 60% of the energy requirements for building operations could be melt from one-site operations capabilities.

ing, probaby 40th to 60th of the energy requirements for building operations could be met from on-site generating capabilities. Clearly, the optimum mix of investment to reduce waste, generate on-site energy and utilize traditional central energy systems will vary from building to building and from location to location. Data do not presently exist with which to develop national models for setting priorities. However, this need not delay the implementation which, after all, will take place on a building-by-building basis. It does suggest, however, that all cases are not equal and that across the board programs, such as tax exemptions to building owners for retrofitting existing buildings, may not yield the optimum mix of investment or conservation.

This leads us to think in terms of a system of energy conservation in buildings composed of a network of "Integrated Energy Packages for Buildings" designed to yield the most appropriate amount of energy efficiency per investment dollar for each building or group of buildings and altimately for the nation. This concept is developed further later.

BASIC CRITERIA FOR IMPLEMENTATION PLANS:

 Evolve a new energy system for buildings with the minimum of institutional economic and political disruption and with the maxinum sharing of the payoffs.

mum sharing of the payoffs

—Provide a source of readily available capital exclusively for the financing of these energy efficient packages for both new and existent buildings.

—Allow separate treatment in terms of accounting procedures and taxes to capital pay backs as an incentive to overcome the present tendency to reduce capital posts in exchange for increased operational costs.

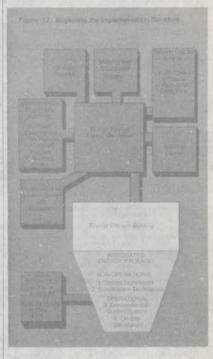
Develop mechanisms by which the energy package's economically self-austraining and paid for from the flow of energy savings until fully recovered.

—Provide for some short-term incentives for immediate returns

 Provide for some short-term incentives for immediate returns with increased return to participants and building owners once the system has recovered its investment costs.

—Provide for the transfer of expenditures from energy consumption into the salvings or investment sector of the economic accounts. This would substitute a capital investment for what would otherwise be consumption expenditures for an essential commodity—energy. —Maintain a final system which permanently provides incentives for technical improvement and sufficient flexibility to readily absorb

Evolve a national capability for comprehensive energy management design and engineering in order to create the most appropriate energy packages.



—Evolve a feasible institutional structure for integrated ownership and maintenance of the energy system, keeping the administration of the system simple and a part of the private sector.

BEGINNING "THE IMPLEMENTATION STRUCTURE

Figure 12 diagrams the implementation structure.

The final product we are seeking is energy efficient buildings.

These buildings can be divided into the integrated energy package and the non-energy parts of the building.
The integrated energy package consists of

-installed components that are non-operational: design tech

-installed components that are operational: environmental con-

Non-installed energy supply systems: These are the hook-ups to traditional electricity, gas or oil systems. These systems must work intimately with the installed operational systems.

work intimately with the installed operational systems. The integrated energy package is shown partially outside the building to indicate that there may be situations in which a part of the energy package is more beneficially shared among more than one building. For example, a shopping mall or center might have solar collectors installed for the complex as a whole and the ability to draw upon integrated traditional supply systems for backup as a group. This is a very significant point, since it suggests a basic need for a system manager/owner who need not draw boundaries at the wall of the particular building being included in the integrated energy package.

Energy System Owner/Maintainer. The energy package would be owned and maintained by a system company which would be

Energy System Owner/Maintainer. The energy package would be owned and maintained by a system company which would be granted licensed territories much like present utilities. Individual building owners, interested in maximizing individual returns, may not make the most effective overall use of capital or of the materials and other components which the system would employ. In isolating a corporate entity whose vested interest is in the energy system rather than the individual building, this breakdown allows the incentive, the administrative structure and the problem of organization the individual approaches to be combined and of organization the individual energy explane to be combined and

of optimizing the integrated energy package to be combined and integrated into a manageable form.

integrated into a manageable form.

Building Owner. Under this arrangement, the building owner sessentially may be the recipient of an energy package which requires no capital outlay on his part. This feature recognizes and is predicated upon an existing situation which tends to make building owners minimize front-end capital investment, even at the expense of increased future operating costs. If the energy system is installed and maintained through someone relate's capital and operating costs, the building owner essentially becomes a lesses.

operating costs, the building owner essentially becomes a lessee. Comprehensive System Design and Evaluation Team. The need would exist for an interdisciplinary system design and evalua-tion team composed of architects and engineers who could, in working with the system owner and the building owner, develop integrated energy packages for the most effective overall building design—including retrofitting energy packages to existing building designs. Were this function to be undertaken by an internal de-partment of the system owner, an important mechanism for control within the system would be eliminated. The objective is to ensure that the investment of the system capital will be optimized from the

standpoint of energy conservation, with minimal regulatory control standpoint of energy conservation, with maintain required y content. The inclusion of an independent professional service is the most effective means by which this could be accomplished. This arrangement would provide the additional advantage of permitting a single integrative design team to serve the critical function of coordinating the non-energy and energy packages of the total

We recognize that such an interdisciplinary capability may not now exist. This team and its function are an integral part of the architect's and engineer's roles and, hence, an extension of their comprehensive professional services. While the function is com-plementary to and extensive of their traditional roles, it incorpo-Takes an estirely new dimension. This "support structure" would have to be developed early in the implementation program. However, given the incremental implementation rate of 7% per year, it seems reasonable to suppose that current professionals could

acquire the needed competence at the required rate.

Builder/Installer. The builders of a new building or the installers of a retrofit system into an existing building would continue to play.

Material and Equipment Suppliers. The industries which so building material and equipment also would continue in their pres-ent role. However, there would be significant innovations within ent role. However, there would be significant innovations within this context. A high priority national program, large scale energy system ownership and comprehensive system design and evaluation teams will create a new aggregate market for energy efficient materials and equipment. This fundamental change from an essentially supply-push to a demand-pull market will facilitate a more rapid recribentation of the present industries and a more flexible use of standards than could ever be achieved under the kinds of regulatory prescriptive standards proposed by many advocates of energy conservation in buildings.

Capital Source. A special capital source will be required to assure that the needed long-term investment money for the integrated energy package is available. We have shown in the preceding section how this capital fund can become self-statining over a period of years and also have shown estimates of the working capital

son how this capital fund can become self-sustaining over a period of years and also have shown estimates of the working capital requirements needed to sustain the fund as a revolving account. It seems best to think of a separate capital fund or funds set up as an investment package for the years required to reach full pay back. At that time, these funds could be handled in a variety of ways. The capital requirements can be met through a combination of borrowing, equity investment and reinvested cash flow.

Governmental Regulatory Agencies. Regulatory agencies will play an important part in providing the framework of public policies which will be necessary to permit the system to become operational, to remain flexible and to be monitored for its performance relative to the public interest.

relative to the public interest.

There are a variety of ways in which this energy system concept could be implemented. We have chosen a scenario which we regard as workable and effective. Substantial modifications of this oversimplified description may become necessary, however, the following paragraphs explain the concept and its basic feasibility within the traditional diversity of the American economic system.

The integrated energy package would be owned, iristalled and maintained by a large-scale energy system utility. This corporation could be a form of the present electrical and gas utilities and would become the manager of an integrated energy system for the built environment within its licensed terrifory. This single system manenvironment within its licensed territory. This single system man-ager would finance the entire integrated energy package. He would reduce the charge to the building owner (energy consumer) by 10% of the energy savings. This will assure the consumer of a single manager concerned with the maintenance of the overall system and with the smooth switching from on-site generation to backup systems. It would also assure full compatibility of all com-ponents of the energy package and provide a workable mechanism whereby the utility would be provided as the provided and energy savings within its assigned territory.

savings within its assigned territory.

Since the utility's return would be based upon capital invested, the utility would have an incentive to invest the capital as rapidly as possible. There would be no advantage to investing capital except in the buildings which would yield the highest savings first. The state regulatory agency would require that the utility present a plan for conversion of its territory which had been developed in concert with one or more registered system designers and evaluators. This plan would define a program for systematically rendering all new buildings energy efficient and retrofiting existing buildings on a basis which would yield, within reason, the highest energy savings potential first.

The integrated energy packages would result from designs by

integrated energy packages would result from designs by independent protessionals in the Comprehensive System Design and Evaluation team. For new buildings, these professionals should normally be the same team involved in design of the building, or at least they should work intimately with that team

Each building which is to be operated with an integrated energy package would then be certified by the designer and reviewed by the evaluator. Subsequently, the utility would arrange for installa

the evaluator: Subsequently, the utility would arrange for installation of the package.

The system would give first priority to new buildings in order to make sure that all new buildings were equipped with integrated energy packages. Owners of present buildings would apply for an energy package because of the incentive of reduced utility bills at no cost to themselves.

The maintenance of the energy system would be more efficient because the utility would provide and monitor a professionally-disciplined maintenance team. This learn could be partially comprised of firms performing similar services now prevalent throughout the nation. Such a system should do much to eliminate problems of quality control and good maintenance of turnaces, air

conditioners, on-site generation devices and other components. The state regulatory agency would establish energy audit systems to conduct spot checks on the entire operation. Such an approach, supported by appropriate sanctions, will do much more to promote energy conservation than pre-control measures such as building codes and prescriptive standards.

as Junioning codes and prescriptive standards.

The utility may finance the system in a variety of ways, it may raise equity capital or borrow to provide the working capital required until the reinvested cash flow becomes self-sustaining.

One of the objectives of the system is to provide a means of con-

verting consumption expenditures to savings or investment.

installed, non-operational components of the energy system are integral to the very nature of the building. These components might be regarded as products which are being lease-purchased by the building owner. At the point his "account" within the capital fund is fully repaid, title to these aspects of the energy package would revent to the building owner. Thus, a portion of the monthly energy exceptions of the monthly energy the product of the component of the monthly energy the statement was a portion of the monthly energy the statement of the monthly energy the monthly energy the statement of the monthly energy the statement of the monthly energy the statement of the monthly energy that the monthly energy the mo bill would constitute an installment toward purchasing that ass

To extend the concept further, the utility could finance the system from capital obtained from a special fund created for that purpose. Each building installation could represent an account with that fund as well as an asset on the balance sheet of the utility. At the fund as well as an asset on the balance sheet of the unity, at the time of installation, stock equal to the value of the energy package could be issued and placed in escrow. Perhaps 20% of that stock would be treasury stock of the utility whereas 80% would be stock in the name of the building owner. When the energy system investment reaches full pay back, the stock certificates would be delivered to the building owner to become an integral part of his building asset value. This stock would automatically be a part of water than the stock certificate in the building asset value. This stock would automatically be a part of water and the building asset value. any sale of the building since it would represent installed property within the building. After payout, dividends then would continue to accrue on the savings and be returned to the system owner and

The basic point is that the incentives can, through a variety of forms, permit equitable distribution of the yields after the capital

The basic point is that the incentives can, through a variety of torns, permit equitable distribution of the yields after the capital investment is repaid. This has the effect of transferring consumption expenditures to asvings, increasing the incentives of the system and ultimately providing an extension of ownership. Based upon the graphs shown in the preceding section, major inflows of capital are required each year for a varying number of years. A national fund for energy conservation in buildings could be established. It could be created as a special revolving fund by the federal government and supplied through annual appropriations until the point is reached where no new capital inflow in retions until the point is reached where no new capital inflow is retions until the point is reached where no new capital inflow is required. Alternatively, it could exist as an aggregation of state funds, with each state issuing state bonds, through a development corporation or some similar entity, to provide a part or all of the funds for energy conservative buildings within its boundaries. Another approach would be to establish special loan funds within the existing banking system or within the existing banking system or within the existing banking system or within the existing mortgage funds market system. It could be some combination of these.

It will probably be desirable to have some form of national co-ordination to assure that the capital is provided in the coort of the control of the control.

It will probably be desirable to have some form of national co-ordination to assure that the capital is invested in the most effi-cient manner to yield maximum savings of energy. Some sections of the country offer superior potentials just as do some buildings. However, it would be better to allow a tolerance of less-than-optimized investment and retain diverse flexible systems than to insist upon a national clearing house of all applications, in essence, funds would flow into these national revolving capi-tal accounts on the basis of an investment commitment for the entire investment block. The internally generated net cash flow from saved energy would be retained for reinvestment until the entire 15-year strategy is implemented and the initial investment repaid.

Should the present utilities not wish to become the prime interator-owner-maintainer of the system, some other corporate entity

would be necessary and could be developed readily. This entity would then become a major negotiator for the energy supplied to the building by the ulliting systems. The only value lost by such an approach would be that the full system would not include the traditional supply sources. However, optimization of the overall system of the latter of the country of the c detonal supply sources. However, optimization of the overall system could still be achieved from a consumption-oriented viewpoint. This might require some additional relationships between the various organizational components and the regulatory bodies.

Many additional derivative scenarios can be written. However, the above should be sufficient to communicate the workability of the concert.

the concept. This workability stems from the fact that all of the ingredients needed to get underway already exist. There are presently many ways to generate capital funds and develop consortia of interdisciplinary skills and complex systems modeling and management. What is needed is an assembly process. This does not mean that much creative work is not required. However, it does mean that there seems little reason to delay getting started. We believe that this program should be launched with a sense of national urgency and pursued as energetically as if it were an emergency priority. emergency priority.

A REVIEW OF ALTERNATIVE STRATEGIES

A number of alternative strategies have been proposed and are

A nonsel or atternance strategies have over ptoposed and as-being pursued by various groups.

Present policy is an approach which essentially says: "Let's rely upon nuclear fusion to restore an era of unlimited cheap en-ergy by the middle of the next century and before the finite en-ergy resources are exhausted." Our argument against this strat-egy was advanced in the original report.

egy was advanced in the original report.

Another approach essentially says that the federal government must fund several years of additional R&D before we have the necessary technology with which to achieve energy conservative buildings. Two: three and four-year experimental programs have been proposed and are in the formative stages. It is unclear what the budgetary altitudino will be, but there is no reason to believe that funding for these conservation efforts will approach the scale of the creat priorities being assigned to coal gasification, shale conversion, strip mining, nuclear development and offshore oil exploration. offshore oil exploration.

offshore or exploration.

One key reason why these more distant payoffs are being pursued in preference to the earlier opportunities offered by an ultimately self-sustaining short-term subsidy required for the strategy for energy efficient buildings is that institutional constituencies already exist for such allocations. We can only constituencies arready exist for such allocations. We can only assume that nothing dramatic will happen to change this situation and that continuation along this route will delay the action needed now if we are to realize the potentials of energy efficient buildings. While such tederal funding of R&D is indispensable to a continuous flow of technological advances which will substantially improve the operational payoffs of energy efficient buildings, it is complementary to and not a substitute for the implementation structure described

Still a third approach adopts the attitude that the market mechanism itself abould be the driving force stimulating energy conservation. Such an attitude essentially assumes that energy will become increasingly expensive. This price increase will be perbecome increasingly expensive. This price increase will be permitted to occur and will create a scramble for conservation strategies which will be implemented as the demand emerges. We maintain, however, that there is no reason to pay the penalties associated with an approach which will substantially and needlessly increase the cost to both the economy and society. Why not begin now to act with vision and leadership rather than waiting to react with desperation and to suffer tragic social coats. social costs?

Social Costs? Finally, there are those who insist that only prescriptive standards of energy efficiency for each of the various environmental control systems will result in the innovational needs and coordinative mechanisms which will best further the cause of energy

While we applaud all efforts aimed at achieving greater energy efficiency in buildings, we believe strongly that a system in which financial incentives are the inherent motivational force will attain its goals more rapidly, inexpensively and creatively than one which attempts to modify behavior by prescription and penalty. We also believe that flexibility for the entire group of building industries will be more consistent with the national of building industries will be more consistent with the hasional interest. Accordingly, we plan now to urge others within the building design professions to join with us in promoting what we believe must be regarded as both a more positive and more effective alternative to achieving the objective of energy efficient buildings throughout the nation by 1990.

THE AIA ALTERNATIVE

THE AIA ALTERNATIVE

The AIA alternative would contribute the supply equivalent of nearly an additional million barrels of petroleum per day, each year until the full potential is reached. Since we have leaned consistently toward conservatism in the preceding estimates, the potential savings are probably well above our projected 12.5 million barrels per day. The energy efficient buildings strategy can be implemented on a self-sustaining basis if undertaken within the context of an investment package over a 10 to 30 year period.

We have found no other concept among the ideas presently discussed which offers equivalent short term benefits in combination with such desirable criteria for long range national energy strategies.

energy strategies,

Therefore, we conclude that there should be no delay in moving ahead with a high-priority national program to begin implementing a national strategy designed to convert the na-tion's building inventory into an energy efficient system by

RECOMMENDATIONS

1. The basic concepts laid out in this report should be devel-It The basic concepts laid out in this report should be developed into operational plans for the conduct of at least six national demonstrations of sufficient scale and diversity to field test the entire concept. These demonstrations should involve the various institutions and skills necessary to recognize and solve the myriad problems and provide the special policy latitude which will be necessary for the conduct of these tests. The mix of institutions could be organized into a task force to develop a consortium capable of designing and conducting the tests by the time the operational plans are complete. tional plans are complete.

The objective is to have all six tests underway by the end of 1975. Simultaneously, a policy and design team could begin to work toward a national structure for rapid installation of the system. With this system established, dissemination could begin as soon as the tests have created sufficient confidence that the implementation structure is reliable. Thus, the test sites might precede broader dissemination by only a few months, at least for significant

broader dissemination by only a tew months, at least for signescant aspects of the system.

2. The AIA Energy Steering Committee and its staff, the AIA Research Corporation, and the contractual policy research team should move ahead immediately to provide cooperative leadership in developing the needed additional details and an interim structure for the forums and ad hoc task forces which will be required.

We wish to stress that the AIA offers coordinative leadership. We fully recognize that no single institution or profession should or could be dominant in such an undertaking. We seek should be considered as the second of the se

energy efficient buildings inroughout the nation by several spirit, we ofter the following additional recommendations.

3. Other building design professions and associations are urged to join with the AIA in an informal coalition with appropriate representation and funding support invitations outlining our proposal in this regard will be issued shortly. This coalition will provide an integrated mechanism through which the building design professions can ofter their counsel and support to the effort while continuing to conduct appropriate research spanning the entire spectrum of interdisciplinary activities. Such a group need not be empowered to speak officially for the represented institutions. Our objective is to begin the process rather than to obtain official objective is to begin the process rather than to obtain official sanction from individual institutions.

 The President of the United States is a critical participant in implementation of the energy efficient buildings strategy. An initiative such as we propose cannot hope to succeed without high priority status and the whole-hearted support of all branches of the federal government. The Executive Branch, with its immediate capacity for funding support and access to a diverse network of professional skills and activities, is a key to this process. We therefore recommend that the President:

a. Proclaim, as a prime objective of his administration, the launching of a high priority national program for energy efficient buildings to be pursued with the vigor of an emergency commit-

Immediately appoint a personal representative to coordinate

b. Immediately appoint a personal representative to coordinate the effort within the appropriate Executive Departments.

c. Consider appointing, within the next 180 days, a Presidential Commission, comprised of appropriate individuals from both the public and private sectors, responsible for having the filled tests fully operational and underway before the end of 1975. At that time, the Commission might be abolished in favor of its more appropriate institutionalization for the follow-through efforts. However, it probably will be thereficial to retain some form of extraordinary organization to monitor and evaluate the continued development and extension of this system.

d. Direct that the federal government launch a program to establish a Federal Revolving Fund from which energy, efficiency capital can be made available for buildings used by the federal government. This directive should require, by mid-1975, a fully detailed plan for federal building acquisition and management which will make all federal buildings energy efficient by 1990. The capitalization of the program would come from the Federal Revolving Fund for integrated Energy Packages in Buildings. Agencies

capitalization of the program would come from the Federal Revolying Fund for Integrated Energy Packages in Buildings. Agencias
would relimburse this fund from operating appropriations in subsequent years according to an appropriate formula in which all of
the savings are rechanneled into the fund until the investment is
fully repaid. The algencies should be further instructed to make
their procedures and experience sixualishe to the private sector and
to otherwise use their activities to stimulate optimal achievement
of the national experience. of the national program.

5 Governors of the various states can contribute valuable sup-

- port. We recommend that each governor take steps appropriate to launching a program for energy efficient buildings used by the State in much the same manner as is described above for the federal government. We emphasize that this system should be one lederal government. We emphasize that this system should be one structured along the outlines suggested in the previous sections of his report rather than in pursuing standards or building codes. The governors should also direct that their representatives begin working in cooperation with the task force to be organized by the AIA. Energy Steering Committee, with the viewpoint that the state might develop breader programs and incentives for all buildings within its boundaries. For example, states could begin to think of establishing a State Revolving Fund for Capital Needs to convert all buildings within the town within the state to evide the programs.
- establishing a State Revolving Fund for Capital Needs to convert all buildings within the state to energy efficiency by 1990. Atternatively, some of the states might wish to organize early in order to qualify as a site for one of the field tests being developed by the task force.

 6. Presidents of utilities, producer, supplier and maintenance companies, and other corporations within the private sector are all intimately involved in and have a tremendous stake in the proposed system. Accordingly, they too could appoint a senior representative within their companies to work with the effort and to provide morests filtrancial suprior as deemed process. The ALA representative winnin their companies to work with the short and to provide modest financial support as deemed proper. The Ala will be extending invitations to selected firms within the next several months. However, any firm wishing to register its dealir to occuperate with the overall effort is encouraged to communicate directly. with the AIA Energy Steering Committee

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IN CONCLUSION

We fully recognize that concepts such as we propose cannot be communicated easily. We do not consider that, at this early stage, the concepts themselves are fully developed it would have been easier to develop a simpler, more confined approach and to limit our ideas to the traditional services of the architectural profession. But to have done so, we believe, would have resulted in further sub-optimization—one of the principal maladies of our time. And mis in turn would deprive the nation of the full potential which energy efficient buildings can offer in solving both our short-and long-term energy problem. As was stated in the original report referenced in the beginning of this document.

The energy problem, like the environmental problem, refuses to comply with our himma and institutional desires to divide things into narrowly defined and easily managed pieces.

Leadership aimed at resolving the energy problem must consider this broad perspective of energy and respond in ways that match its magnitude and complexity, rather than relying solely on traditional approaches.

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T03-549-2801

PROPOSAL FOR
AND ANALYSIS OF
AN INTERIM LEGISLATIVE STRATEGY
TO ACHIEVE
ENERGY EFFICIENT BUILDINGS

The Energy Steering Committee
of the
American Institute of Architects

June 1975

SUMMARY

This proposal outlines THE NATIONAL ENERGY EFFICIENT BUILDINGS ACT OF 1975. The American Institute of Architects recommends that this act be put into effect as soon as possible. It offers several times more benefits in terms of energy conserved than other conservation proposals before the Congress. In addition, it captures this energy potential without incurring the undesirable economic and political side effects which accrue in varying degrees under all other current proposals.

These benefits include:

- Conservation of an average of 850 thousand additional barrels of petroleum equivalent per day each year until 12.5 million barrels per day or more is reached in fifteen years. These are permanent savings which continue indefinitely.
- A non-inflationary stimulus of 2 million or more jobs in a depressed area of the economy, sustained over the next fifteen years.
- Substantial and increasing savings to millions of energy consumers.
- No need for onerous price or tax penalties or other forms of inflation-feeding means of forcing energy conservation on the public.
- 5. A probable net increase in U. S. Treasury collections.

The details behind these employment and Treasury impact estimates are contained within this proposal.

Further details on the overall potential of and strategy for a national program to achieve energy efficient buildings are contained in two major AIA energy reports:

- "Energy and the Built Environment: A Gap in Current Strategies" (May, 1974)
- "A Nation of Energy Efficient Buildings by 1990" (February, 1975)

AN OUTLINE BILL

An outline of the proposed bill to be used by legislative drafting staff is contained in Appendix A.

The principal features of the legislation are:

- It applies an incentive approach in lieu of regulatory standards to achieve energy efficient buildings. This will result in substantially more energy savings than would regulatory standards.
- 2. It applies to both existing and new buildings.
- It provides incentives to all building owners: business and personal residence.
- 4. It provides two basic incentives: one for making an initial investment sufficient to achieve a minimum of 30% savings in existing buildings and 60% savings in new buildings; and an additional incentive for further investment and operational efficiency which will reward achievement of savings greater than these minimums. Thus, the incentives are designed to optimize conservation, by offering further rewards for higher levels of achievement.
- 5. Business owners have two options for the first incentive:
 - a. Taking an investment tax credit in the year of investment and amortizing the remainder over a normal useful life; or
 - b. Taking a five year write-off for the total investment.
- Home owners may elect to deduct the costs of their qualifying investments in any year up to a maximum of five years.
- 7. Both business owners and home owners are allowed an additional tax credit equal to 30% of the value of energy actually documented as having been saved beyond the minimum levels of 30% and 60% for existing and new buildings respectively.
- The basic controls over the quality and effectiveness of the program are exercised through a system of certifications by qualified professional practitioners. No expensive nor cumbersome regulatory apparatus of government is needed.

ESTIMATED STIMULUS TO EMPLOYMENT

The proposed Act will be a major non-inflationary stimulus to employment in a depressed sector of the economy. The unemployment rate in the construction

industry was nearly 20% in April, twice the national average. The utilization rate of the industrial capacity in the building and construction industries was well below the 66% rate for manufacturing operations as a whole. Thus, stimulus to employment specially targeted on the construction and building design industries would be non-inflationary stimulation. Moreover, this stimulation will begin to be felt immediately and should remain stable for at least fifteen years. Few programs for "revitalizing" the building and construction sector of the economy offer such potentials.

The first step involved in estimating the number of jobs to be created entails estimating how much capital investment is required to create one job in the construction/building industries. Figure 1 shows that in 1975 each job in this industry requires about \$45,000 of contract investments.

FIGURE 1: ESTIMATED INVESTMENT REQUIRED TO CREATE ONE CONSTRUCTION INDUSTRY JOB IN 1975

Year	Construction Put in Place \$ Billions	Persons Employed in Construction	\$/Person
1960	\$ 54.738	2,885,000	\$ 18,973
1965	73.747	3,186,000	23,147
1970	94.855	3,381,000	28,055
1972	124.077	3,521,000	35,239
1973	135.437	3,649,000	37,126
	4 Annual Increas	e, \$/Person	
1960-65	4.0%/year	1960-70	4.0%/year
1965-70	3.9%/year	1965-73	6.1%/year
1970-72	12.1%/year-	1970-73	9.8%/year
1972-73	5.3%/year		

(Source: Statistical Abstracts of U. S., 1973)

Since we know that 1974 was an extremely inflationary year for contract construction and we expect that construction in 1975 will be at still higher costs, we will use an average increase of 10%/year in \$/Person since 1970, continuing the 1970-73 rate. This gives a figure of approximately \$45,000/Person for construction jobs in 1975.

Obviously, the number of jobs created will depend upon the level of total investment and upon the multiplier used to estimate the total employment effect. The exact amount of investment which would be stimulated by the proposed bill is not determinable. The rates needed to have a nation of energy efficient buildings within fifteen years are selected as the most desirable. They are 7% per year for conversion of existing buildings and 100% per year for new buildings. These rates would allow orderly industrial development and absorption of the markets for energy efficient building components.

However, in the next section of this report we show a range of estimated rates. The lowest case shows a 1% rate of conversion for existing buildings with 10% of the new buildings being energy efficient. The high estimate assumes a 10% conversion rate of existing buildings with 100% of new buildings being energy efficient. These varying assumptions as to the mix and rate of conversion are also related to a range of estimates about the amount of investment required to achieve energy efficiency in buildings. These costs are estimated at 10%, 15% and 20% of the value of the construction. When all of these are combined, the per year investments flowing into the national economy will range from \$3.2 billion to \$64.1 billion. We believe the most likely investments will be between \$25.5 billion and \$50.9 billion (shown by the heavy border enclosure in Figure 2).

FIGURE 2: ESTIMATED JOBS CREATED BY THE PROPOSED NATIONAL ENERGY EFFICIENT BUILDINGS ACT OF 1975

	Case	\$ Spent	@ \$45,000/Job	0 Prime X2	Total Jobs	
	1% existing and 10% new buildings,					
	10% cost of package 15% cost of package 20% cost of package		70,000 105,000 140,000	140,000 210,000 280,000	210,000 315,000 420,000	
	7% existing and 100% new buildings,	7				
le	10% cost of package 15% cost of package 20% cost of package	25.5B 38.1B 50.9B	565,000 845,000 1,130,000	1,130,000 1,690,000 2,260,000	1,695,000 2,535,000 3,390,000	Most Probable Range
	10% existing and 100% new buildings,			TO DE THE		
	10% cost of package 15% cost of package 20% cost of package	32.1B 48.1B 64.1B	715,000 1,070,000 1,425,000	1,430,000 2,140,000 2,850,000	2,145,000 3,210,000 4,275,000	

Probab Range

4

Applying a factor of \$45,000 per job, we calculate the number of prime jobs directly created. A multiplier of two has been used in estimating the number of additional jobs stimulated for each of these prime jobs. The final estimate of the number of jobs created ranges from 210 thousand to 4.275 million. We believe the most likely results will be between 1.695 million and 3.390 million (see Figure 2). The total unemployed in the nation in April was over 8 million.

FINANCIAL IMPACT ON U. S. TREASURY

FACTORS INVOLVED IN MAKING THE ESTIMATE

There are a number of factors to be taken into account in estimating how the proposed bill would affect the U. S. Treasury:

- The basic categories or ingredients comprising the cash flow impacts upon the Treasury;
- The levels of participation and investment by building owners;
- 3. The amount of energy saved; and
- The multipliers to be used in determining gross impact upon the economy or the GNP.

Five Basic Ingredients Classify the Cash Flow. Five basic ingredients are involved in estimating the net financial impact upon the U. S. Treasury. Two of these are positive, three are negative:

efficient investments.....

The Amount of Gross Investments. Before going further with any of the five ingredients discussed above, it is necessary to estimate the gross investments made to obtain energy efficient buildings. This figure will be the result of several basic factors:

- 1. The number of building owners who act on the incentives.
- The costs of the Integrated Energy Packages associated with the investment to which the incentive applies.
- The ratio of business to personal/residential building owners.
- The percentage of business owners who elect option A versus those who elect option B in terms of the investment incentive.

The Percentage of Energy Savings. The incentives are of two basic types. The first incentive is to stimulate investments necessary to reach the threshold minimums of 30% savings in existing buildings and 60% savings in new buildings. The second incentive is to reward achievements beyond these minimum thresholds. The first incentive is calculated on the basis established by the actual allowable costs of investment in energy efficient buildings. The second is calculated on the documented savings in energy beyond the minimum levels. Thus, the percentage of savings is significant in determining the effect upon the Treasury.

The Multiplier Effect of the Economic Stimulus on Gross National Product. Just as was the case in employment, each dollar of prime input to the economy stimulates indirect economic activity. There are no accurate estimates of what the specific multiplier for this type of investment would be. We have included estimates for no multiplier at all, for one additional dollar for each prime dollar and for two additional dollars for each prime dollar. We believe a conservative estimate would fall between one and two dollars of indirect GNP for each dollar of direct GNP.

CONSTRUCTING THE MODEL FOR MAKING THE ESTIMATE OF IMPACT

How Many Participants. We begin by estimating the number of buildings which will be converted. This can be expressed, for our purposes here, in terms of the percentages of existing and new buildings which would be converted to energy efficiency. We envision a range of possibilities from a very low of 1% to an optimistic 10% per year for existing buildings. New building participation

rates should be higher. Thus, we use a low estimate of 10% of new buildings up to an optimistic 100%.

This can be visualized by the matrix in Figure 3. The vertical axis begins at the top with a low of 1% conversion per year of existing buildings and increases down the axis to 10%. The horizontal axis begins at the upper left hand corner with the low estimate of 10% for new buildings and rises to 100% at the far right. This matrix gives a range of "sets" which should encompass all reasonable possibilities.

FIGURE 3: LEVELS OF PARTICIPATION

		New Buildings								
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
14	Low									13
22								18		
328								N.		
277										1
5.2										
72 62 52 42										
77					19.15					AIA Rpt.
\$16 00							N.			
26										1
102						1	1			High

The smallest participation would be in the upper left hand cell, the highest in the lower right hand cell. The rates used for making the national estimates in the AIA reports referenced earlier were 7% and 100% respectively for existing and new buildings. For our purposes here, we can cover the range of

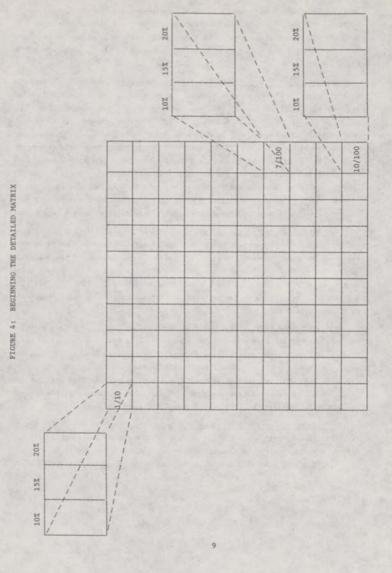
possible impacts to the Treasury by taking the lowest and the highest cells. We have, however, added calculations for the 7%/100% cell used in the AIA reports, since we believe this to be a reasonably achievable objective and since it is the recommended target rate to achieve a nation of energy efficient buildings by 1990.

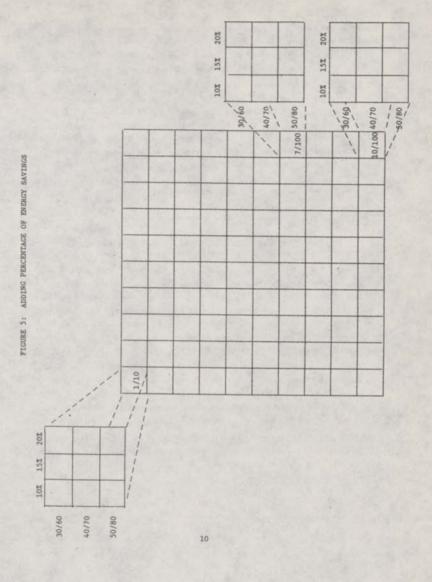
Estimating the Costs of Integrated Energy Packages. Each building presents a unique case. There is no effective way to estimate just what the optional investment for energy efficiency will be. However, in the AIA energy report, "A Nation of Energy Efficient Buildings by 1990," it was determined that a reasonable range of investment costs in obtaining energy efficient buildings may fluctuate between 10%, 15% and 20% of the cost of the construction. This report contains the detailed calculation for gross investments on a national level for each of these percentages. Those data are used here to calculate the investment flow. Thus, we expand our model shown in Figure 3 to include these three levels of cost. This is done by making each of the three cells of the matrix used in Figure 3 into the beginning of a supporting and more detailed matrix (see Figure 4).

Estimating the Percentage of Savings. Another important factor affecting cash flow into the Treasury is the percentage of savings which are achieved over and above the minimum requirements of 30% and 60% for existing and new buildings. We therefore expand the supporting matrix shown in Figure 4 to incorporate three levels of savings in existing and new buildings respectively: 30%/60%, 40%/70% and 50%/80%. This gives us the vertical axis of the supporting matrix begun above and is shown as Figure 5.

Estimating the Ratio of Business and Personal Residential Owners. It is now necessary to divide the data calculated above into the investments and savings related to businesses and those related to private residences. We have estimated that 60% of these investment costs will be business related and 40% private residence related. The details of how these estimates were derived are contained in a technical Appendix B (available upon request). This categorization, however, imposes an intermediate classification into our supporting matrices.

Estimating the Option Elected by the Business Actors. We now modify the estimates to take into account the fact that businesses may elect either of two options with respect to their investment incentive: 1) A tax credit in the first year of 10% of the allowable cost followed by a normal amortization period of 30





years for the remaining balance; or 2) A rapid amortization period of five years for the total allowable costs. Clearly, each building owner will elect the option which will give him the maximum advantage. However, the range of possible mixes can be calculated by assuming that either all take option A or all take option B.

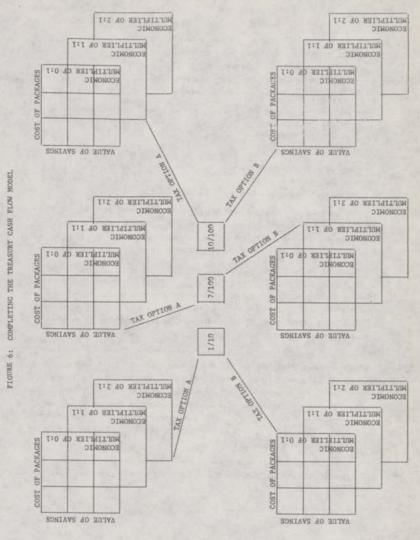
Estimating the Total Economic Impact on the GNP. The federal government collects approximately twenty cents in revenue for each one dollar of GNP. The amount of GNP stimulated by this proposed legislation depends upon how many dollars of indirect economic activity will occur for each dollar of investment in the energy packages. As mentioned previously, we have estimated the impact upon the GNP under three basic assumptions:

- Only the direct investments in energy packages will be added to the GNP (multiplier of zero).
- Only one additional dollar of GNP will result from each dollar of this direct investment (multiplier of one).
- Two dollars of additional GNP will result from each dollar of the direct investment (multiplier of two).

Summarizing the Model. We can now see that the "model" with which we are working contains several categories. It would require many calculations to completely fill in the model. However, for present purposes it is the possible range of impacts that is important, together with the estimate of the impact of a reasonably achievable program. Figure 6 shows, in summary form, how we have arrived at deciding upon eighteen case illustrations as the basis for estimating the range of possible impacts upon the Treasury.

We begin in the center with the three combinations of participation levels as depicted in Figure 3. We expand each of these combinations into two sets of illustrations for business option A and option B, and then for the three different levels of economic stimulus. Thus, there are six supporting matrices for each of the combinations for rates of participation.

Each cell within each of these matrices will include the net effect upon the Treasury for each of the first five years of the program and the total effect for the full five years of the program.



The net effects will be the result of calculations for each of the basic ingredients affecting the cash flow of the U. S. Treasury (discussed above):

- 1. Revenues from economic stimulus.
- 2. Revenues from increased corporate income.
- 3. Losses for tax incentives.
- 4. Losses of utility income taxes.
- 5. Losses due to interest deductions.

These calculations must be made for each of five years and then summed to show the total five year impact.

MAKING THE ESTIMATES

The actual estimates for each of the basic ingredients are detailed in a technical Appendix B which is available upon request. A summary of the key factors used for each ingredient is contained below.

Treasury Revenues Derived from Increased GNP. For several years the federal revenues have equalled about 20% of the GNP. Thus, for each of the varying levels of GNP stimulus attributable just to the investments in energy conservation packages it is estimated that 20% will be returned in gross federal revenues.

Treasury Revenues Derived from Increased Business Income Taxes Attributable to Reduced Energy Costs Now Treated as Operating Costs. We have estimated that 50% of the energy savings would be business savings, that energy costs would increase during each of the five years at an average rate of 15% over a base year of 1972, and that the value of energy saved would be an increase to taxable income taxed at an average rate of 48%.

Losses from Tax Incentives. We have estimated that 60% of the investments would be business investment and 40% for personal residences. Separate illustrations are calculated for business impacts under options A and B. It was assumed that under option A all businesses would take the maximum 10% tax credit in the year of installation and amortize the remainder of the investment over 30 years. Option B was calculated under the assumption that all businesses would elect a five year write-off of the total investment. In each case, the average tax rate was assumed to be 48%.

The estimated cost of the investment incentives to personal residences was based upon the assumption that all homeowners would take their maximum deduction

in the year of installation, since this is the worst possible effect upon the Treasury. Average income tax rates associated with these deductions were estimated to be 30%.

The additional tax credits related to energy savings in excess of the 30% and 60% minimums were estimated at two additional levels of savings based upon 15% average increase in energy costs per year and upon an estimate that 30% of these additional savings would be a direct credit deducted from taxes due. This assumes that all participants would have sufficient tax liability against which to take the credit, again the largest possible cost to the Treasury.

Losses from Decreased Income Taxes of Utilities and Energy Wholesalers
Which Result from the Conserved Energy. We have assumed that all of the value
of the estimated energy savings would be a reduction of gross revenues of utilities or other energy wholesalers and distributors. Utilities average paying
approximately 5% of their gross sales in income taxes. Thus, we have assumed
that 5% of the value of the energy saved will become a loss to the Treasury
through these reduced tax revenues.

Losses from Deductions Taken for Interest Associated with the Investments Stimulated by this Bill. Not all of the integrated energy packages will be financed with borrowed funds. We have assumed that 50% of these investments will be financed through loans, and that this percentage will apply to both business and non-business owners. We have further assumed an average interest rate of 8% per year and have calculated this on the gross estimated loan value without providing for declining balances. This overstatement should more than compensate for any understatement which would result from a slightly higher percentage of the investments being made through loans. We assumed that business deductions would be at a 48% tax rate and that personal deductions would be at an average tax rate of 30%. We then developed a composite tax rate to be applied to the composite interest deduction. This composite rate of 40% takes into account our estimate that there are slightly more loans made for business purposes than for personal purposes. (If the amount of these two categories of loans were equal, the composite rate would be 39% or half way between 30% and 48%.)

ESTIMATED NET FINANCIAL EFFECTS ON THE U. S. TREASURY

Figure 7 shows a composite table of all of the cases calculated for illustrative purposes. This table contains the extreme cases, and shows that the effect on the Treasury may vary from a maximum net increase over the first five years of \$147.9 billion to a maximum net loss of \$38.0 billion. However, as noted earlier, we believe the most likely results will fall within the mid-range impacts of 7% participation for existing buildings/100% for new buildings, and that the economic multiplier should be between 1 and 2.

Accordingly, our estimate of the most probable impact upon the Treasury is that there will be a net increase to Treasury revenues of between \$19.5 billion and \$94.9 billion.

More importantly at this participation rate this policy will save more than 4.65 billion barrels of petroleum within this first five years; and these savings continue year after year without additional cost or reduced standards of living.

To the American consumers, this represents a total savings in just these first five years of \$75 billion if energy costs average \$14.83 per barrel (a 15% annual increase from the current \$11.00 per barrel).

To the American economy, it represents the equivalent reduction of energy import requirements as well as a significant stable employment base.

FIGURE 7: FINANCIAL EFFECT ON U. S. TREASURY (\$ Billions)

			1.34		COST	F INTEC	RATED I	NERGY I	ACKAGES	3		
				10%			15%			20%		
		ECONOMIC			PERC	ENTAGE	OF ENER	GY SAVI	NGS			
		MULTIPLIE	30/60	40/70	50/80	30/60	40/70	50/80	30/60	40/70	50/80	
NGS	N B	0	- 0.8	- 1.1	- 1.3	- 2.0	- 2.3	- 2.5	- 3.3	- 3.6	- 3.8	
INGS	OPTION	1	3.1	2.8	2.6	3.5	3.2	3.0	4.2	3.9	3.7	
BUILD	TAX	2	6.6	6.3	6,1	9.4	9,1	8.9	11.6	11.3	11.1	
1% OF EXISTING BUILDINGS 10% OF NEW BUILDINGS	A NO	0	0.7	0.4	0.2	0.2	- 0.1	- 0.3	- 0.2	- 0.5	- 0.7	
	OPTION	1	4.6	4.3	4.1	5.7	5.4	5.2	7.3	7.0	6.8	
	TAX	2	8.1	7.8	7.6	11.6	11.3	11.1	14.7	14.4	14.2	
NGS	8 3	0	- 6.6	- 8,9	-10.6	-16.4	-18.7	-20.4	-25.9	-28.2	-29.9	
DINGS	OPTION	1	23.5	21.2	19.5	28.8	26.5	24.8	34.5	32.2	30.5	
BUIL	TAX	2 1	53.7	51.4	49.7	74.0	71.7	70.0	94.9	92.6	86.9	
EXISTING BUILDINGS OF NEW BUILDINGS	N A	0	5.3	3.0	1.3	1.3	- 1.0	- 2.7	- 2.3	- 4.6	- 6.3	
N N	TAX OPTION	1	35.4	33.1	31.4	46.5	44.2	42.5	58.1	55.8	54.1	
100	TAX	2	65.6	63.3	61.6	91.7	89.4	87.7	118.5	116.2	114.5	
NGS	TAX OPTION B	9.00	0	- 8.6	-11.1	-13.8	-20.7	-23.2	-25.9	-32.8	-35.3	-38.0
100% OF EXISTING BUILDINGS 100% OF NEW BUILDINGS		1	29.1	26.6	23.9	35.9	33.4	30.7	42.7	40.2	37.5	
		2	66.8	64.3	61.6	92.4	89.9	87.2	118.4	115.9	113.2	
	N A	0	6.1	3.6	0.9	1.5	- 1.0	- 3.7	- 3.3	- 5.8	- 8.5	
	OPTION	1	43.8	41.3	38.6	58.1	55.6	52.9	72.2	69.7	67.0	
	TAX	2	81.5	79.0	76.3	114.4	111.9	109.2	147.9	145.4	142.7	

EXECUTIVE SUMMARY

0F

A SYSTEM TO ACHIEVE ENERGY EFFICIENT BUILDINGS: DEMONSTRATION PROGRAM PLAN

AIA ENERGY STEERING COMMITTEE

FEBRUARY 1976

INTRODUCTION

This summarizes institutional and economic concepts that can effectively achieve energy efficient buildings throughout the nation. In addition, an action plan is outlined for launching needed field tests and demonstration projects. The report serves as a backdrop for the AIA's current initiative to organize a national coalition of key industrial, financial, professional, and governmental institutions to provide leadership for carrying the plan forward.

This study is part of the American Institute of Architects' research program to develop ways for the design professions to contribute significantly to solving the energy problem.

The first report, "Energy and the Built Environment: A Gap in Current Strategies," (May, 1974), estimates the potential energy savings in building operations by 1990 to be the equivalent of 12.5 million barrels of petroleum per day. This is about equal to the projected supply capacity of energy to be produced from domestic oil, or domestic and imported natural gas, or nuclear power, or coal. Later data have shown the estimated savings from buildings to be on the conservative side and the projected supply capacities from traditional energy sources to be optimistic, thus increasing the value of achieving a nation of energy efficient buildings as soon as possible.

The second report, "A Nation of Energy Efficient Buildings by 1990," (February, 1975), contains estimates showing that energy efficient buildings are economically feasible. In a period of projected capital shortages, investing in saving energy is much more cost effective for the nation than investments in producing energy for inefficient consumption in buildings. The report contains an initial outline of institutional/administrative structures which can make achievement of energy efficient buildings administratively feasible.

In addition to these reports, the AIA is developing a <u>National Energy</u> <u>Efficient Buildings</u> Act. This proposal outlines temporary tax incentives to aid in immediate stimulation of energy efficiency pending longer term and more permanent institutional innovations.

There is a growing acceptance of the idea that significant benefits would accrue to the nation if our building inventory were made energy efficient. The technical capacity to achieve energy efficiency exists, but, unless significant institutional innovations can be developed, it will be many years before energy efficient buildings comprise a significant percentage of the nation's building inventory. The key needs are for institutional structures and mechanisms which will:

- Provide economic incentives for front-end capital investments to save energy.
- (2) Provide economic incentives resulting in increased operating profits as energy savings increase.

- (3) Integrate both the design and management of procuring, installing, and maintaining the necessary components of energy efficient buildings and the connection of such buildings to traditional backup centralized energy systems.
- (4) Develop an overall "delivery system" of equipment producers, design professionals, installation contractors, maintenance crews, centralized energy producers, financiers, and governmental entities.
- (5) Aggregate a sufficient market for the individual components of individual energy efficient buildings so that the delivery system mentioned above is economically feasible and self-sustaining.
- (6) Possible incentives to encourage rapid technical developments as this dynamic "new industry" emerges.

Present technical development and demonstration programs do not envision projects of sufficient scale to meet the foregoing needs. These programs can, however, be relied upon to develop prototype buildings which will show the results of applying certain conservation mechanisms and techniques. This report takes those developments as a basis upon which to build. Thus, while some of the projected savings are still inadequately documented, that gap should be filled before the first pilot project proposed herein reaches the point of actual implementation. Appropriate modifications to the plan can be incorporated as these data become available. Present indications are that the estimates used for this report will prove to be conservative.

BASIC CONCEPTS

Distinction Between Energy Conservation and Energy Efficiency

A differentiation between energy conservation and energy efficiency is critical to an appreciation of the systems developed in this report. Energy conservation, in the traditional sense, is conceived of as an absolute reduction in energy consumed. Energy efficiency, on the other hand, is considered an absolute reduction in the consumption of energy which is derived from nonrenewable resources. Under a concept of energy efficiency, it is possible to enjoy the productive and qualitative benefits of energy, while at the same time reducing demands upon the earth's scarce traditional energy sources, e.g., oil, gas, coal. Emphasis is placed upon utilization of renewable resources, i.e., those which occur as the result of natural phenomena such as solar, wind, water power, and geothermal activity. Thus, the concept of energy efficiency is considered socially, politically, and economically more beneficial than adherence to narrowly defined energy conservation standards.

An Energy Efficient Building Energy System

The six required institutional structures and mechanisms mentioned above can be most effectively achieved through a specialized energy subsystem. This subsystem is termed An Energy Efficient Building Energy System or, for short reference, a Building Energy System. The Building Energy System (BES), in

addition to buildings themselves, will be a network of suppliers and producers, design professionals, financiers, contractors, homeowners, and government agencies. This system must not be confused with a building's internal energy systems, which are discussed later as components of the building's Integrated Energy Package.

In this system, which includes the entire logistic and support delivery/market system for Energy Efficient Buildings, buildings are regarded as producers as well as consumers of energy. Centralized electrical, gas, fuel oil, and coal systems will be drawn upon only for residual requirements, not gross requirements. On-site production generally will be limited to conversion of natural energy flows such as solar and wind.

Integrated Energy Packages

The combination of design and construction techniques and energy equipment which makes a given building energy efficient is termed Integrated Energy Packages (IEPS). The IEP is not a fixed collection of items, but rather a selected assortment of practices and hardware tailored to each specific building. IEPS will be retrofitted into existing buildings and designed into new ones. Both operational and nonoperational components are envisaged, as are design practices, control equipment, and, where feasible, such practices as energy transfer between various buildings within a given complex or locale.

IEPS are to be developed through an individual energy analysis performed on each building by qualified energy specialists.

A Building Energy Utility

The organizational entity responsible for integrating and managing all of the components of the BES will be the Building Energy Utility (BEU). The BEU is conceived of as an entrepreneurial private enterprise venture; however, it could be effectively operated as a publically owned enterprise as well. While this BEU could be launched as a division or subsidiary of an existing electrical, gas, or other energy-supply company, it also could be a new venture capitalized in its own right.

The utility concept is employed not because of present electrical and natural gas system arrangements (which are usually operated as some form of utility), but because it will be beneficial to have a territorial monopoly for effective integrated management of the BES. A closer analogy to the type of utility described is the telephone system. The BEU will own and maintain equipment installed within buildings, and will build its maintenance and updating costs into the rate structure which will be constructed on a building-by-building basis.

Individual Building Rate Structures

All energy costs chargeable to a given building will be billed through the BEU. Thus, while electric and gas companies will continue to supply energy directly to building sites, they will bill and receive payment from the BEU. The BEU will, in turn, bill for all energy costs to the building owner or occupant. The amount to be charged will be based upon a rate established for each building equal to the costs of energy had there been no IEF installed. Costs will be a composite of imported energy costs, maintenance costs normally borne by a building owner, and depreciation costs on "normal" energy components packaged within the building.

Each building owner will receive an immediate participation discount equal to at least 10% of the value of energy savings. These savings are estimated to be up to 50% for existing buildings and up to 80% for new buildings. As soon as the BEU has recouped its investment in that particular EIP (usually from seven to twenty-five years), the building owner will receive a dramatic reduction in energy bills of as much as 45% or more. The owner will receive a further reduction after the BEU has fully depreciated the IEP. The procedure is analogous to a long-term lease purchase arrangement. Rates of depreciation will be consistent with Internal Revenue Code Guidelines.

The BEU pays for design and installation of the IEP's, all energy imports, maintenance of IEP's, and related external components of the system, territorial planning, depreciation of the IEP's, and general administration and management costs.

Special economic incentives are structured to encourage capital investments that will result in saving energy. Operating profits, a separate category of return for the BEU, become larger as energy savings increase; at the same time, energy costs for the building owner decline as energy savings increase. Thus, both the seller and the buyer have incentives to save rather than to sell or to consume energy derived from nonrenewable sources.

A National Coalition

Major institutional innovations are not easily achieved. A National Coalition is envisioned as the instrument for providing the sustained leadership necessary to stimulate action. This coalition will be comprised of representatives of key institutions which have an interest in seeing the program undertaken, and which collectively have the capacity to form the nucleus to launch a Building Energy System. The American Institute of Architects is inviting interested partles to join in organizing this coalition as the first step of the following action plan.

THE DEMONSTRATION PROGRAM PLAN

A demonstration program is the proposed means for developing final operational procedures and field tests which will determine the feasibility of the concepts. The demonstration program will consist of (1) a number of individual demonstration projects (from one to nine); (2) a national coalition to provide overall leadership, coordination, assistance and evaluation; (3) an orientation project to develop a network of informed leaders throughout the nation which is capable of launching similar programs within local communities. Detailed procedural manuals will be a product of the demonstration projects.

Each demonstration project will be a territory containing at least 10,000 buildings which will be included within the demonstration analysis. These buildings will reflect a variety of functions, sizes, and construction types. The demonstration plan envisions converting at least 2,000 of the buildings to energy efficiency in annual blocks of at least 500.

A pilot project should be started in 1977 with any additional demonstration projects following by a lag of at least several months. This will minimize the likelihood of repeating initial errors and will also capitalize upon experiences gained in the pilot projects.

The implementation plan covers eighty-four months and is divided into three basic overlapping phases:

- Phase I: Organization and Start Up (months 1-18)
 - Activate National Coalition
 - 2. Acquire demonstration project initiators and sponsors

Phase II: Project Operation (months 9-78)

- 1. Each Demonstration Project
 - a. Project organization

 - Territorial plan and IEP design
 Procurement systems and actions
 Operation and maintenance
- Program leadership, coordination, evaluation, and overall assistance
- 3. National orientation/training program

Phase III: Wrap-Up

- 1. Issue final documentation and evaluations
- 2. Complete national dissemination strategies

The plan is structured to permit any state or even a local community to take the initiative and launch a demonstration project. Of course, the federal government could assume a leadership role as well. No new national legislation is required to launch the program.

A local or state Building Energy Utility (BEU) can be capitalized in a variety of ways. The key alternatives are discussed in the report, along with preliminary detailed twenty year financial projections for a pilot project assumed to begin in 1977. A number of individual building account illustrations are also developed.

These estimates are based upon the following key assumptions:

- a) The BEU "capital" will be provided on a basis equivalent to equity capital.
- Building owners will receive an immediate incentive to participate by being guaranteed a reduction in their energy costs equal to 10% of their nonparticipating maintenance and depreciation costs plus 10% of the savings in energy imports.
- c) a 4% cash return per year will be allowed investors plus an additional operating profit of 10% of actual savings realized.
- d) Cash flow generated by the BES not required to pay these incentives or cash operating costs will be reinvested in the system.
- The initial 2,000 buildings will be converted to energy efficiency in four annual increments of 500 buildings per year beginning in 1977.

- f) Average costs of imported energy (electricity, natural gas, etc.) will increase by 15% per year from 1978 to 1983, then 10% per year until 1988, and 4% per year thereafter to the twentieth year.
 - g) Average costs of maintenance, administration, and construction will increase by 6% per year from 1978 to 1983 and 4% thereafter.

The overall twenty year performance of such a pilot project is summarized in Figure 1.

Conclusion

The report concludes that the feasibility of the program warrants immediate organization of the national coalition and launching of one or more demonstration projects. Substantial incentives and advantages will accrue to building owners, investors and operators of the BEU, suppliers, professionals, and others who comprise the Building Energy Systems.

The benefits to the nation will be even greater. They go beyond the energy question itself, and deal with economic and institutional innovations which may serve our economic and political systems well as they seek to adjust to an increasing scarcity of nonrenewable resources. The approaches suggested here seem better fitted to a free society than either rationing by governmental allocation or prohibitive pricing—the major alternatives now dominating the contemporary marketplace of ideas.

Therefore, responsible leaders in both government and industry are urged to join the American Institute of Architects in forging ahead to convert the concepts into realities.

FIGURE I: SYSTEM STATUS AFTER TEAR OF

ELECTED FINANCIAL PERFORMANCE AND ST	ATUS	(millions)	(millions)
Cash reserves Undepreciated book value of init Undepreciated book value of rein		\$ 19.287 72.455 394.759	\$486.501
Initial paid in capital/stock ou (1.773 million shares @ \$100)	tstanding	\$177.300	
Building owner equity Original IEP's Reinvestment	\$11.124 24.402	35.526	
Unpaid balance on loans to mortg IEP's from new buildings Criginal IEP's Reinvestment	6.513 42.231	48.744	
Retained equity from residual ca	sh flow	\$224.931	\$486.501
Per share book value, Year 1 Per share book value, Year 20 Dividends paid, per share		(dollars)	(dollars) \$100.00 227.00 56.00
Earnings per share in year 20 Operating profit Operating surplus		\$ 3.00 22.43	25.43
Return on shareholder investment dividends plus increase in book Annual			

Compounded 5.29%

NUMBER O	F BUILD	INGS IN SYSTEM	ORIGINAL INVESTMENT	REINVESTMENT	TOTAL
	Class	A	1,000	1,400	2,400
	"	В	472	644	1,116
	11	C	472	588	1,060
	"	D	36	56	92
	"	E	16	-0-	16
	11	F	4	-0-	4
		Total Buildings	2,000	2,688	4,688
	2	Total Square Feet	20M	24M	44M

ENERGY SAVINGS

Cumulation from year 1 through year 20: BTU's 39.2 X 1012

6.75 million Equivalent barrels petroleum In year 21 and annually thereafter on just these 4,688 buildings: BTU's 2.5 X 10¹² Equivalent barrels petroleum .60 millio .60 million

Capital investment in year 3 required to build centralized systems adequate to generate the amount of energy saved:

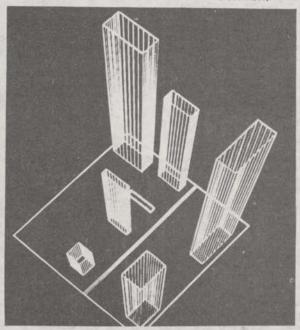
All Electricity \$210 million All Gas 43 million Gas/Elec. mix currently used in buildings 105 million

Energy Conservation Research: A Key To Resolving The National Energy Dilemma

THE FIRST ANNUAL REPORT

THE NATIONAL ADVISORY COUNCIL
ON RESEARCH IN ENERGY CONSERVATION

December, 1975



About the Council

The National Advisory Council on Research in Energy Conservation provides a focal point for the promotion of effective national programs of energy conservation research. Organized in December of 1974, the Council is an outgrowth of several studies and a survey conducted by the American Institute of Architects which demonstrated the need for such a forum. The Advisory Council's approach to conservation emphasizes achieving greater energy efficiency through technological and institutional advances rather than through a resort to price manipulation or energy rationing.

The Council's annual reports develop needed conceptual frameworks for analyzing the overall status of, new directions in, and funding levels for a balanced, comprehensive program of energy conservation research on the national level.

Occasional white papers and special reports on specific topics are also issued, often in response to special requests.

The Council also provides a forum for the informal exchange of ideas and viewpoints between the private and public sectors.

While institutional support is provided by the American Institute of Architects, the Advisory Council is a fully independent body which retains its own executive secretariat and research staff support through a contract with Charles W. Williams, Inc., of Alexandria, Virginia. Members of the Advisory Council, their institutions, and nonmember supporters provide financial support for the Council's work.

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Energy Conservation Research A Key To Resolving The

National Energy Dilemma

THE FIRST ANNUAL REPORT

of

THE NATIONAL ADVISORY COUNCIL ON

RESEARCH IN ENERGY CONSERVATION

December, 1975

FOREWORD

This first annual report is the initial public statement of the National Advisory Council on Research in Energy Conservation. As the research leading to this report was beginning, there was a limited appreciation of the long range significance of energy conservation in resolving the nation's energy problems. Conservation was generally discussed in the context of gasoline rationing, lowered thermostats, and shutdowns of industrial operations in order to prevent immediate fuel shortages.

In reviewing the past year, we are encouraged by developments which signal the emergence of new attitudes. As this report indicates, the federal government is now more cognizant of the importance of energy conservation. In addition, private efforts like our own have begun to promote conservation programs as an integral part of national energy policy. However, while conservation has achieved a higher priority, present research policies continue to overemphasize technical developments in supply-oriented strategies. A recent analysis conducted by the Congressional Office of Technology Assessment indicates that energy conservation represents an equally valid investment in terms of budget priorities and offers near-term payoffs. This is our belief.

A comprehensive, unbiased view of energy conservation research and activities is the objective of this report. Key factors include:

- Concepts of conservation which do not require a reduced standard of living or diminished quality of life.
- (2) An overall framework for evaluating the dynamics of national energy policies.
- (3) Integrated views of present energy supply/demand forecasts and of present conservation research activities.
- (4) A comprehensive framework for balanced national research programs.
- (5) Initial suggestions for appropriate funding levels and for the composition of a balanced national program for energy conservation research.
- (6) A specific framework for a national program of research on energy conservation in the built environment.

It is our sincere hope that public and private officials concerned with energy policy will evaluate our suggestions carefully and will take appropriate actions wherever possible. We also hope that our fellow citizens will familiarize themselves with the opportunities and benefits associated with such a comprehensive program. An informed constituency is essential to create the support which our leaders will require if the nation is to realize the potential in energy conservation.

Leo A. Daly

December, 1975

EXECUTIVE SUMMARY

The National Advisory Council on Research in Energy Conservation has prepared this study as its first annual report. Organized in December of 1974, the Advisory Council is a private-sector forum established for the purpose of promoting an effective national program of energy conservation research. Beginning with this report, and through future reports and activities, the Advisory Council hopes to develop workable blueprints for transforming energy conservation into an actual, as opposed to a rhetorical, component of national energy policy.

This report clearly shows that energy conservation should become one cornerstone of a comprehensive energy policy, but that present national activities do not give conservation the priority which it should and must have. As the report points out, delay in undertaking and funding energy conservation research will reduce the nation's flexibility in dealing with future energy problems. Without a reorientation of energy priorities, the opportunity to shape a more favorable and secure energy future may be irretrievably lost

Highlights of the report's key features and points are:

- a concept of energy conservation which stresses energy efficiency instead of a reduced standard of living or diminished quality of life;
- a role for energy conservation as a complementary strategy to increasing the supply of fuels;
- overall frameworks for strategically evaluating the dynamics of national energy policies;
 - integrated views of:
 - (1) present supply/demand forecasts-
 - (2) varying estimates of the conservation potential in different sectors of the economy-
 - (3) present energy conservation research (with concentration on the federal government's R&D efforts);
- a rationale for devoting priority attention to energy conservation in the built environment;
- a comprehensive framework for a balanced, national research program in energy conservation;
- initial suggestions as to appropriate funding levels and the general composition of such a research program.

Energy conservation can be viewed from a number of perspectives. As defined in this report it means the reduction of demand for energy from nonrenewable resources. This concept entails:

- reducing demand on large-scale, centralized generation and distribution systems;
- increasing the efficiency of energy consuming systems, and;
- increasing reliance on small, on-site or end-use conversion systems and nondepletable energy sources (such as solar).

Drawing on this definition, the source of energy may be more important from a conservation standpoint than the amount of energy which is consumed in a particular situation.

Just as energy conservation can be defined in various ways, it can be acheived through a variety of strategies. A major focus of the report is the achievement of greater energy efficiency through technological and institutional changes. Although a leaner and more efficient energy system will also require attitudinal and life-style adjustments, these factors have not been extensively considered in this report. While some life-style changes may be both desirable and beneficial, the report stresses that forced conservation either through pricing or regulation is undesirable and unnecessary.

Special attention is devoted to energy conservation in the built environment. This area of concentration was chosen because it is still grossly neglected despite the fact that it offers one of the largest, near-term conservation payoffs. As detailed in the full report, energy conservation in the built environment is more fully consistent with the most desirable energy strategy—one characterized by increased reliance on renewable resources, diversity of input capabilities, minimization of pollution, and improved system efficiencies—than are many other alternatives for conservation which are currently receiving priority attention.

Conservation in the built environment is examined in the broader context of ongoing and planned conservation research. Because the federal government appears likely to play a dominant role in conservation research and development for the foreseeable future, federal programs and research projects are most carefully scrutinized. The report seeks to identify major research gaps and suggests corrective action. Included in this analysis are suggestions as to an appropriate framework for structuring a national research program for energy conservation in the built environment and recommended funding levels for the program outlined.

The report's general conclusions may be summarized as follows:

- No sufficient national strategy or plan (including provisions for needed research and development) for achieving energy conservation exists.
- Present plans, which address only one aspect of the energy problem, depend upon a strategy of refilling supply lines through further exploitation of fossil fuels and relying upon nuclear energy as a replacement prior to the exhaustion of nonrenewable resources.
- Present energy policies place conservation in an undesirable context of having a negative effect upon individual quality of life.
- The need for effective energy conservation is real, urgent, and of long-term duration.

 Although energy conservation is supposed to be a major component of national energy strategy, present and proposed funding levels belie the reality.

 If such an imbalance continues, it will probably cause the nation to miss capturing most of the conservation potential for at least two decades.

 The conservation potentials associated with the built environment are sufficient to close the projected energy supply gap over the next three decades; however, there are sevete doubts that present policies will capture that opportunity.

In order to remedy the shortcomings associated with the present approach to energy conservation, the Advisory Council recommends:

e that the federal government declare a high priority national program to achieve a nation of energy efficient buildings as the basis of a dramatically expanded research and development program;

 that a national energy conservation strategy be developed based upon forecasted advances in knowledge and technical capabilities which could be achieved with a high priority research and development program;

• that funding for energy conservation should be

rapidly increased to approximately \$300 million per year-about 1 percent of the value of potential annual savings to be derived from conservation measures;

that, of the total funding recommended, \$170 million per year be designated for the built environment;

 that achivement of energy conservation should be regarded as a complex innovational problem and that a comprehensive innovation strategy should be developed to replace the present concentration on smallscale demonstration projects.

These recommendations reflect the belief that the technology necessary to achieve substantial energy savings is presently available in most cases. In the short term, attitudinal and institutional problems must be identified and overcome if energy conservation technology is to be disseminated throughout the economy. In addition, a comprehensive research and development program must be initiated to develop second generation technologies and new strategies for implementing energy conservation over the long-term. By acting now where possible and by planning for the future, the nation can capture the potential of energy conservation and ease the transition to an era of new demands upon our energy resources.

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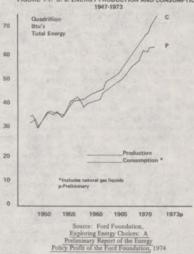
CHAPTER I: INTRODUCTION

BACKGROUND

During the last quarter century, the United States has moved from a position of an exporter to an importer of progressively growing amounts of energy.

Beginning in 1970, domestic production of energy actually declined for the first time. This dramatically widened the already increasing gap between consumption and domestic production (see Figure 1-1). Since the early 1950's this gap has been primarily filled by importing petroleum.

FIGURE 1-1: U. S. ENERGY PRODUCTION AND CONSUMPTION



A number of long-evolving factors combined to produce the situation. Even through the 1960's, the price of energy relative to other products declined, so that energy continued to be a bargain and consumption was stimulated. At the same time, new public policy decisions during the latter 1960's based on economic and environmental considerations slowed the growth in production and processing of domestic fuels. Without complementary policies aimed at limiting consumption and developing alternate, cleaner sources of energy, the United States relied more and more upon importing foreign energy fuels.

With the imposition of the oil embargo by the Arab states in the winter of 1973-1974, what had been a future problem suddenly became an immediate one. The overlooked gap between domestic consumption and production became painfully apparent to both policy makers and consumers. Eventually, the oil tap was turned on again and the crisis atmosphere eased, but in the interim the fourfold increase in the price of oil by the OPEC nations had created a new set of problems. Fuels to meet America's growing appetite were again available, but the price seemed prohibitive. Almost overnight, the era of cheap and abundant energy had come to an end.

Initially, government leaders called for achieving energy independence by 1980. Although voluntary action to conserve energy was encouraged, legislative and research proposals concentrated heavily upon increasing domestic energy production with related price increases to force reduced consumption.

It soon became clear, however, that energy independence within this century would not be achieved. A range of new technologies will be required and there are undesirable economic and environmental costs. Estimates of U.S. exploitable fossil fuel sources have also been revised downward. Thus, even if the United States can dramatically increase its energy conservation and production of fuels from traditional sources, unless alternative sources of energy can be developed, the exhaustion of nonrenewable resources will finally force a decline of our energy budget. For some analysts, nuclear energy seems to hold the promise for the future, but to others, nuclear energy is a "Faustian" bargain. Thus, energy must be both a long-range and an international problem for U.S. policy.

More and more individuals have come to see that a comprehensive effort to reduce the growth rate of energy consumption has to accompany efforts to increase energy production. Some have proposed a new "conservation ethic" which would stress restrained consumption, environmental protection and, wherever possible, the utilization of renewable energy sources.

Although a new awareness of the need for a more intelligent use of energy has been partially created, there has been little real progress in eliminating energy waste or developing alternate sources of energy (except nuclear).

Thus far both governmental and industrial leaders have searched in vain for programs that can achieve the degree of energy conservation sufficient to reduce demand compatible with realistic supply capabilities. Much greater percentages of the conservation potential must be achieved than present programs will yield. A long-term, high priority, balanced national research program to achieve energy conservation is

already a matter of urgent need. This need will become more acute as we move through the 1980's and 1990's.

Research efforts require long lead times. The nation is already behind schedule on this important research agenda. Action to operationalize energy conservation strategies continues to lag.

The following chapters will show how important it is to place a high priority upon conservation as a cornerstone of our national energy policy.

DEFINITION OF ENERGY CONSERVATION

Energy conservation is used in many contexts but usually means some form of conscious action designed to reduce the consumption of energy derived from nonrenewable resources.

Some proposed energy conservation ideas require actions which impose penalties upon our standards of living or comfort, our quality of life, economic development and well-being, and our freedom of action. Examples are high prices on gasoline to limit consumption or outright rationing. Other contemplated actions are mandatory temperature controls in buildings. These are, to be sure, ways to achieve energy conservation. But these are not the tactics which this Council seeks to promote.

Also included under the above definition of energy conservation would be such efforts as developing capability for large-scale centralized electrical plants to convert solar energy. Nuclear fusion, which can produce more usable fuel than the raw material fuel it consumes, is another current concept for conserving nonrenewable resource based energy. But once again, these are not the forms of conservation falling within the purview of this Council.

Energy conservation, as used by the Council, will mean the reduction of demand for energy from nonrenewable resources. It will also mean the reduction of demand on large-scale centralized generation and distribution systems that might use any energy raw materials. Moreover, it is reduction of demand which comes about from increasing the efficiency of the operations of our energy consuming systems. Small scale on-site or end-use conversion and nondepletable energy (such as solar) are included at energy conservation measures.

Conservation is not to be advocated just for conservations sake. There may be areas in which the utmost technical efficiency must be wived because of economic, political, or social nonfeasibility. We believe that these less repressive opportunities should be fully exploited ahead of "pane" measures which, in the light of subsequent events, will be seen to have created unnecessary hardships.

This rather general definition will take on more specificity as the reader moves through the following chapters.

THE FOCUS OF THIS REPORT

Clearly, the scope of energy conservation even as defined above covers many complex phases of our economy, crosses

all types of institutions, and affects all facets of life. Accordingly, Council reports concentrate upon specific areas for more detailed treatment. This report will deal with the area of energy conservation in the built environment. The term "built environment" is broadly defined. It includes the design, construction, and operation of buildings and the spatial relationships of buildings and various functions. The way in which the built environment evolves affects where and how we live, work and play, how we must travel, and many dimensions of the quantity and type of energy which we must consume.

CONCLUSIONS AND RECOMMENDATIONS

The key conclusions stemming from the following chapters can be summarized as follows:

- There is presently no sufficient national strategy or plan (including needed research and development) for achieving energy conservation.
- (2) Our basic operational national energy strategy is to refill the energy supply lines by further exploitation of fossil fuels and rely upon nuclear energy to be the replacement before these nonrenewable resources are exhausted. Solar energy, as a renewable resource, appears as a major source for further development.
- (3) The need for energy conservation is real, urgent, and of long-term duration. Projected energy supply deficiencies over the next three decades are of such magnitude as to require either drastic measures to curtail consumption or such substantial imports as to cause serious economic problems for the entire United States economy and for every citizen. These impacts can, however, be avoided if we develop and sustain a high priority, effective national program of energy conservation until a renewable energy source is developed.
- (4) Although energy conservation is supposed to be a major component of the nation's energy strategy, proposed funding levels belie the reality. The federal budget for FY1976 continues to relegate conservation research to a relatively meaningless position. If this imbalance continues it will likely cause the nation to miss most of the conservation potential for at least two decades.
- (5) Many present energy policies place energy conservation into the context of undesirable and unnecessarily onerous tactics which have negative effects upon individual quality of life.
- (6) The conservation potentials associated with the built environment are more than adequate to close the projected supply gap for the next three decades, but there are severe doubts that present policies will capture this opportunity.
- It is entirely possible for the nation to correct the current deficiencies in energy policies and to develop a comprehensive approach for effective achievements of energy conservation which:

- (a) is in the interest of both individuals and nation.
- (b) is adequate to solve the projected supply gaps, and
- (c) will place our nation's energy system onto a more desirable long-range pathway.

The key recommendations for how to begin are:

- (1) The federal government should declare a high priority national program to achieve a nation of energy efficient buildings. This program should become the basis for a dramatically extended research and development program which is outlined in Chapter V.
- (2) A national energy conservation strategy should be developed which is based upon forecasted advances in knowledge and technical capabilities which could be achieved with a high priority research and development effort.
- (3) Funding for energy conservation should be rapidly increased to about 1% of the value of the potential annual savings. This funding will approximate \$300 million per year. Of this total, we recommend in

Chapter V that \$170 million be designated for the built environment. This percentage approach is admittedly derived in a rather arbitrary manner. However, in reasonably new areas of research it is difficult to use a "bottom-up" approach. We would point out that if this amount were expended each year for fifteen years with no returns (obviously there would be some immediate returns) and the estimated savings shown in Chapter III began in the 16th year, the total fifteen year outlay would be recouped within the sixteenth year. In addition, actual allocations would be based only upon firm project proposals.

(4) Achievement of energy conservation should be regarded as a complex innovational problem. Present concentration on small-scale demonstration projects (especially in the built environment) is neither an adequate nor effective mechanism for achieving such innovation. A comprehensive "innovation strategy" should be developed. This strategy will require substantially more knowledge which well-funded and balanced research efforts can generate relatively quickly.

CHAPTER II: UNDERSTANDING THE ENERGY SYSTEM FROM A POLICY PERSPECTIVE

Development of sound energy policies depends upon a clear and comprehensive understanding of our "energy problem" and of our "energy system": what it consists of, how it has evolved, and how it could evolve in the future.

DEFINING THE ENERGY SYSTEM

The energy system can be thought of as a complex series of major subsystems. Five basic subsystems have been identified for this analysis:

- A. The World Inventory of Basic Energy Resources: the natural system into which man intervenes in capturing energy for his use (sun, wind, petroleum, coal, natural gas, etc.). Nature too uses many of these same natural energy systems in complex ecological relationships.
- B. Energy (Raw Material) Acquisition Systems: the process developed by man to acquire energy raw materials (animal training, mining, oil wells, dams, etc.).
- C. Intermediate Conversion and Distribution
 Systems: processes through which the initial energy raw
 materials are converted to a more useful form (electrical
 generating plants, oil refineries) and transported (pipelines, trucks, trains, electrical transmission lines, etc.).
- D. End-Use Consumption Systems: places where the energy is actually converted into productive work such as heating and cooling buildings, driving industrial machinery, and powering engines in autos and planes.
- E. Environmental Exchange Systems: the natural eco-systems which bear the residual effects of man's acquiring, processing, and using energy.

These five basic subsystems have never been static. Throughout most of history the principal sources of energy have been human labor and domesticated animals. Then inventions began to occur which used natural energy flows. Sails were mounted on ships and windmills were constructed; waterfalls were used (either from creation by nature or by construction of a dam) to power mills; habitations were fashioned to take advantage, of natural features for human comfort at home and at work; heat was derived from local materials, largely wood and coal.

These early energy systems have two features worthy of note.

(1) All five basic subsystems were operated in close proximity to and as an integral part of the end use system. For instance, the breeding, growth, capture, and/or training of work animals required extensive systems of acquisition and transportation. However, the energy source was placed at the point of consumption in its natural form. No intermediate conversion of form was necessary. The conversion or utilization of the energy took place directly at the point of consumption as a part of the end use system.

(2) Nonhuman and nonanimal sources were employed only through various forms of intervention which "organized" the natural flows occurring anyway and which had no significant impact upon either the quantity or the quality of such energy sources. These might be called man-organized energy systems.

The invention of the steam engine, the discovery of electricity, and various other landmark technological developments of the industrial age introduced a new era of energy. Demand and usage began to grow more rapidly and more sources were developed. Wood and coal were used in greatly increasing amounts as fuel. Later, centralized electrical generating plants began to emerge, representing a major form of intermediate conversion and a major new type of distribution system. Note that this conversion later occurred in a centralized plant remote from the end-use systems.

In other areas of everyday life, petroleum became more popular. The internal combustion engine was developed. Large-scale petroleum refineries (a form of intermediate processing) evolved. Gasoline and fuel oil distribution systems grew.

Similarly, natural gas was introduced on an increasing scale. Pipelines were installed to more and more locales and facilities. And, more recently, nuclear power has entered the scene.

Among the principal energy features of this industrial era were:

- A continuing trend to substitute mechanical energy for animal energy.
- (2) An overwhelming reliance upon nature's capital for energy raw materials (finite, nonrenewable resources).
- (3) A rapid expansion of energy sources and known world reserves (hence, the phrase "an era of abundant energy").
- (4) A reduction in the relative proportion of energy costs to other costs of production and of living (hence, the phrase "an era of cheap energy").
- (5) Development of large-scale and complex logistical systems for initial acquisition of the energy raw materials.
- (6) Evolutions of systems which require extensive intermediate and centralized conversion and/or processing plants for the energy raw materials before they are placed in usable form at the point of use.
- (7) Related evolution of extensive transportation and distribution systems for both the raw materials and the converted or processed intermediate energy: rail-

roads and pipelines to move coal, petroleum, or natural gas from the mines and wells to the electrical generating plants and refineries, and then the distribution systems to get the electricity and refined petroleum to the points of end-use.

- (8) Institutionalization of a strong and powerful "bias" to solve present and future problems by extensions of existing systems.
- (9) An increasing inertia and much longer lead times required to affect basic changes even after decisions to change have been reached.

From this brief summary it can be seen that there are two basic categories of energy raw materials:

"Nature's Current Income Energies" are those sources of energy which are naturally recurring and renewable and whose use does not diminish the chance of future utilization of the same resource. Examples are hydropower, tidal power, and solar energy such as light, heat, wind, and thermal ocean gradients.

"Nature's Capital Energies" are those nonrenewable (finite) substances whose use for energy at a given time is a permanent consumption. Included in this category are nuclear fission and the hydrocarbon family (coal, petroleum, natural gas).

There are also two basic categories of man's energy systems:

- Man-organized energy systems that reorganize natural forces in a manner that yields energy as a by-product of renewable natural energy flows.
- Man-made energy systems that perform a permanent conversion of energy stored by nature in one form (such as petroleum) into a consumption unit which is not a by-product of natural forces but a permanent exchange of a nonrenewable resource.

Figure 2-1 summarizes this model of the energy system.
Using this analytical scheme, the energy problem then
can be defined as the combination of:

- Determining and securing sources for the adequate supply of energy raw materials (fuels).
- Determining what demands are to be fulfilled at what price and in what manner.
- Technologically linking these supply and demand relationships through some form of "optimal efficiency" in terms of need or demand, cost, and resource management.
- Maintaining acceptable and prudent environmental exchanges balanced in terms of the consumption of finite natural resources, the restoration of natural balances upset by man's intervention, and the way in which residuals or pollutants are dealt with.

SELECTED ENERGY POLICY ISSUES VIEWED FROM THE STANDPOINT OF THE ENERGY SYSTEM SUPPLY AND DEMAND

All operators within the energy system are concerned with supply and demand. However, both terms mean different things to different people, are viewed from different time horizons and perspectives, require entirely different management approaches and actions, and operate under differing economic and political processes. Generally speaking, what is today termed "the national energy problem" has grown from the basic problem of equalizing supply and demand.

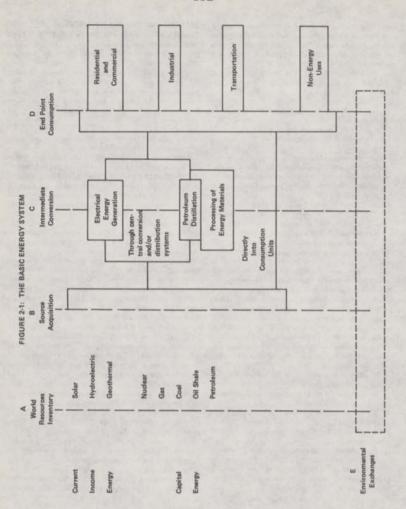
We begin by observing how the operators in each of the five basic subsystems view these questions.

The demand for energy begins with individuals operating in the end-use systems; home and building owners, corporations and industrial plants, trucking and transportation systems for movement of goods, individuals deciding to purchase autos, take plane or bus trips, live in the suburbs and commute to work, etc. It is readily apparent that energy demand is not a pure demand in and of itself. It results from other demands, such as decisions to have air conditioning, certain lighting levels, or additional buildings. In this sense, then, energy demands are derived demands, not primary demands, at least so far as the end user is concerned. However, energy becomes a prerequisite to being able to fulfill primary demands effectively.

Thus, the end user becomes interested in energy supply. Because the system has evolved as it has, however, the consumer generally does not think of the end-use system as a potential conversion system for energy. Rather, the users think of themselves almost exclusively as purchasers of energy supplied in a readily usable form to accommodate their needs. Thus, the end user thinks of "hook-ups" to electrical lines, to natural gas lines, to fuel oil or coal deliveries, to corner gasoline stations, etc. The end user of energy becomes a purchaser of a consumption good whose supply should be assured by the smooth functioning of some other set of energy institutions operating within the system: utilities, gas companies, and so on. In this sense, the consumer purchases energy from an energy retailer.

The "energy retailers" may encompass several companies or institutions operating in an interrelated chain. For our purpose here, they will be considered as a unit.

To the energy retailer, energy demand is a primary demand—it is what retailers are in business to provide. This function may involve a combination of processes which can acquire fuels for energy in one form, convert them into another form, and distribute them to the consumer. For example, electric companies—whether publicly or privately



owned-operate large, centralized generating plants which receive coal, natural gas, petroleum, or other forms of fuels and convert these materials into electricity which is then distributed through complex lines to the energy consumers. The electric company generally purchases its energy raw materials (except in the case of hydroelectric dams) from companies primarily engaged in materials acquisition.

Any intermediate processor or distributor can be viewed in the same light, although a single corporation may operate across several subsystems. For example, a major oil corporation is involved in drilling crude oil, buying crude oil from foreign or other sources, transporting the crude oil to refineries, operating the refineries, operating trucking or pipeline systems to distribute the refined products, and in some instances operating the retail outlets which make final delivery to the energy consumer—as in the case of gasoline, for example.

In other cases, of course, these various intermediate processing conversions and distributions are carried out by specialized companies operating within a segment of the system.

These "energy retailers" must make extensive capital investments. It takes several years for them to develop new plant and/or distribution capacity. Thus, their perspective of energy demand is that it is a primary demand which they must anticipate at least several years into the future. If an average of five to seven years is required to get additional capacity into operation and another thirty or so years is needed to amortize capital investment, it is apparent that huge investment and business decisions are made on the basis of expected demands for the next two, three, or four decades:

These forecasts of demand are absolutely critical aspects of economic survival. From them flow various decisions which will profoundly affect all aspects of our national life. By and large, the anticipated demands are derived by projecting past demand patterns into the future.

The retailers, then, become intermediate raw material consumers, who in turn look toward someone else to acquire their basic energy raw materials. Electrical generating plants buy coal, natural gas, and petroleum. Refineries buy crude oil. Natural gas companies (in terms of their retail function) buy gas at the well head, etc.

Those engaged in acquiring the basic energy raw materials can be termed "energy wholesalers," remembering that in some cases the same firm may act in several of these key roles.

The energy wholesalers view demand in much the same way as the retailers. They make projections of future demand. Like the retailers, they too must make extensive capital investments which require long lead times. If present supplies are considered inadequate, they must locate additional supplies.

If present energy technologies are inadequate, the energy

industries must be concerned about new technologies. Thus, it is natural that the petroleum and natural gas industries are concerned about expanding their inventory of known reserves, expanding the technical capability to tap new reserves—such as deep ocean drilling—and paying attention to such environmental difficulties as massive oil spills.

It is also natural that the preferred new sources of energy are new supplies of the same energy raw materials which are already in use, maintaining the present system structure. Therefore, research seeks to expand our scientific and technological knowledge to the point that oil can be extracted from shale rock, coal converted to gas, and nuclear electric plants built to feed the present electrical distribution systems.

SOME SUBTLETIES OF SUPPLY/DEMAND RELATION-SHIPS

There are many factors working within the energy system which make normal economic assumptions about market mechanisms less useful than is true in many other areas of the economy. The petroleum, natural gas, coal, and other subsystems are structured in such a way that the consumption units have little short-term flexibility in shifting to alternative systems. This tends to make demand become increasingly inelastic-even though prices increase, consumers have only limited choices beyond continuing consumption at marginally different rates. Consider, for example, the choice available to an individual who has bought a home in the suburbs but works in a city where no public transportation exists. He must use gasoline to commute to and from work. Or consider what options the electrical consumer may exercise. How many people could live effectively in today's America without electricity in their homes and places of employment? In this sense, energy systems tend to evolve "lock-in" positions in which the demand becomes increasingly inelastic as the user's capital investment required to convert to alternative sources of energy goes up and the flexibility of conversion goes down-either by virtue of the costs of conversion or the availability of a substitute.

Problems of short-run inflexibilities are also prevalent throughout both the retail and wholesale levels of the supply, intermediate conversion, or processing and distribution systems. Most of these systems are established to capitalize upon economies of scale. For example, even though about 2/3 of electrical power is lost in the conversion and distribution process, electricity is still relatively cheap because of the economies of scale that can be realized through the large generators. Present strategies essentially lock us into these large-scale systems. Generally speaking, the larger the economies of scale are, the larger the capital investment must be. There is, of course, the pressure to utilize the full productive capabity of the installed generating capability.

The fact that most energy systems are operated as utilities adds another distorting picture to the economics of energy policy. Competition within a given territory between suppliers of the same type of energy is very limited. Fuel oil and coal can be competitive, but natural gas and electricity are traditionally supplied by companies which have been given a territorial monopoly. At the same time, the rates which can be charged are controlled by state and/or local governments. If the total capacity of the energy plants is not utilized, the company does not lose money; rather, the per unit cost of the energy sold is increased. Thus, the utility is assured of recovering its cost plus a "fair" return on investment. This leads to such paradoxes as those seen during the 1973 oil embargo and energy crisis. Citizens were requested, even directed, to conserve energy. They did so. As a reward for their efforts, within a few months the utilities were requesting price increases, partially because of the fact that all of their generating capacity was not being used.

Thus, there are pressures which operate to utilize the full productive capacity of installed generating capability. If, after a few years, an extensive capability is built to convert coal into electricity, the system installed to do this will become a political and inertial force to stimulate the consumption of its product even though it encourages throughput consumption of a nonrenewable resource. There is little historic precedent for an industry encouraging a limitation of the use of its products or services. It seems quite unfair to expect the energy industries to behave differently. In fact, our economy would probably not tolerate such behavior.

This is an important point when one is considering policies with respect to conservation. The most opportune time to encourage effective conservation investments is before the installed generating capacity has been created. After that has occurred, conservation investments cost appreciably more because the economies of savings may not be realized even by the consumers.

It has been noted that both end-use consumers and energy retailers who operate the intermediate conversion and processing and distribution systems are limited in any short-term substitution of alternative energy sources. The electrical power system is the most extensive of the intermediate converters. Major arguments are now being advanced that the electrical industry should be rapidly expanded because electricity is one of the most versatile forms of energy to be delivered to the consumption point, while at the same time it permits a variety of raw material inputs: petroleum, coal, natural gas, nuclear energy. This characteristic essentially permits the conversion system to handle the shifts between the various raw materials as the supply ebbs and flows. There are, therefore, proposals to "electrify the nation" as an important part of energy policy.

The surface "diversity" of electricity makes this option appear attractive. But it should be noted that most generat-

ing plants have been specifically designed to convert one type of source material, such as coal. It is an expensive and lengthy process to change the capability of such a processing and conversion plant to accept a different fuel. This feature tends to limit the realistic short-term flexibility of even the electrical system with respect to source materials.

In our present system, the energy demands that are to be filled are determined essentially by the market mechanism, i.e., anyone's demand for energy is considered legitimate so long as there is a willingness and ability to pay. This might be termed nondifferentiated or nonlegitimated demand. The ultimate purpose for which the energy is being consumed is a purely private matter. In fact, until the last two years, the energy suppliers have aggressively sought to "create demand" for their products, just as other businesses. Examples include developing bargain rates for all-electric homes and for volume users of energy. These practices are consistent with the traditional economic rationality which seeks to optimize the return on the investment in a given enterprise. There has been a great deal of promotion to drive production up in order to drive costs per unit down. Thus, the more demand, the better

As the previous discussion makes clear, the present supply/demand structures can become self-stimulating upward spirals. Projections of more demand by suppliers stimulate plans to increase supplies. Any temporary oversupply will tend to stimulate consumption, which in turn will produce projections for more demand, thus requiring more supply capacity.

Now it appears, however, that it will be increasingly difficult to meet the supply levels required to sustain the growth in demand. Thus, a variety of ideas are being set forth which tend to question the legitimacy of demand determined purely on the basis of economics and the ability to pay. For example, questions are being raised as to why we should be able to draw indiscriminately upon systems which result in consuming—for what some regard as frivolous reasons—increasing amounts of the earth's nonrenewable resources.

An increasing concern can be expected within the national energy policy for deriving ways in which demand might be legitimated. The present debate centers around whether to set prices high as a restraint on demand or whether to ration as a restraint on demand. The tension between these questions of what type of energy for what types of purposes will become a more evident issue in energy policies over the next several decades.

These considerations of supply/demand should be concluded by again emphasizing the relative inflexibility of the supply/demand situation. The highly centralized energy supply systems are so complex and capital-intensive that it takes about a decade or more to make substantial adjustments. This means that interruptions in building capacity or in developing the supply system—such as a technological breakthrough in nuclear energy that does not occur (perhaps

the fusion process will not become feasible until after the turn of the century)—inject a problem which cannot be immediately remedied. The slowdown in construction of refining and electrical generating capabilities during the debates about environmental quality is going to result in shortages of energy supply capacity that cannot be compensated for in less than the next 10 or 15 years. Thus, relatively short-term interruptions in the evolution of the energy system can introduce relatively long-term periods of scarcity because of the time required to compensate elsewhere within the overall system. This makes it likely that the early difficulties of the oil embargo of 1974 are indicative of the future rather than a temporary exception.

BASIC STRATEGIES

The conceptual differences must be established between policies, which are general statements of goals and the means for achieving them; strategies, which are the operational plans for executing policies; and effects, which are the outcomes or consequences of the strategies pursued. Not all of the effects of strategies are announced and deliberately sought goals. For example, there has never been a deliberate strategy which has proclaimed the deterioration of our environment as an objective; yet from a practical standpoint, environmental deterioration has been a long-term consequence of the types of strategies which have been pursued. This difference can be thought of as the difference between rhetorical or proclaimed policies and operational or actual results of what we do regardless of what we say, Intended policy becomes operational strategy, and frequently results in consequences which are unintended. would have not been deliberately pursued, and which are extremely difficult to deal with once they have been allowed to accumulate and become institutionalized for extended

In understanding both the potential and importance of energy conservation as one cornerstone of a prudent national energy policy, we must understand present policies as operational strategies. The foregoing paragraphs on supply and demand characteristics of the present energy system began to introduce us to some of these strategies. However, we need to go into some further detail.

Strategies Concerning Energy Source Materials

1. A Strategy of Throughput Consumption—which is used here as the conversion of energy materials that are nonrenewable and which, after being converted, are essentially exhausted. That is, when petroleum or coal has been burned, there is no way to recycle it back into the basic world resources inventory. It is a permanent, irreversible and irreplaceable conversion.

2. A Strategy of Long-Term Renewable Energy Sources—this would entail the use of such resources as wood—items which can be renewed within several decades. For practical purposes, this category is included here only for theoretical accuracy. There are no significant programs or energy systems using these renewable resources.

3. A Strategy of Energy Recovery-which is used here as the conversion of materials that are the residuals or waste from other previous processing. Use of garbage and other forms of solid wastes to generate electricity is an example. The recovery technologies are beginning to take more definitive and commercialized form. It seems safe to assume that during the next ten years or so they will begin to be more common. Opportunities for conversion to these systems are particularly high in areas such as large suburban developments where the basic investments in traditional sewers and other waste disposal systems have not been made. From the standpoint of energy conservation, this is only a relatively more desirable strategy, since it may be only a modification of throughput consumption. Many of the waste materials that can be recovered are the residuals of other industrial processes which used up nonrenewable resources. However, it is also true that many of these wastes are derived from long-term renewable resourcessuch as wood that goes into the production of paper. It should be noted that recycling technology is progressing at such a rate that reprocessing of the waste materials into other useful products may be more desirable than their second consumption for energy which would make them nonrecoverable. Nevertheless, the concept of using recycling for energy generation has some promise, and deserves a place in any strategic framework.

4. A Strategy of Natural Processes—the last strategy has to do with a return to the concepts of man's intervention in nature to reap energy as a byproduct of natural processes by a conversion procedure which does not deplete nature's resources. These were the types of energy transactions which man developed early in his history.

Strategies Concerning Energy/Environmental Exchanges and Effects

1. Nondifferentiated Demand to be Supplied as the Top Priority without Adequate Regard to Side Effect—this is the basic strategy which was dominant with respect to environmental exchanges until the middle to late 1960's, when concern for the environmental impact of our industrial and economic activities began to make itself felt in political terms. Such things as the exploitation of forests, the scars of strip mining, dirt dams holding water from inadequately controlled mining operations, and oil spills with their attendant dead marine life are all well documented and need no further discussion here. Prior to surfacing of these concerns, the basic strategy of supply and acquisition was to extract

raw materials at the least cost without too much concern for the environmental impacts incurred in the process.

2. Non-Differentiated Demand-to be Supplied with a Strategy of Restoring Understrable Environmental Side Effects-this is the same basic strategy as that discussed above in terms of the sanctity of demand. However, it differs significantly in its treatment of the environmental side effects which flow from extraction of the energy raw materials. This strategy includes concern for cleaning up oil spills, for restoring strip-mined mountains to their more natural state, and for pursuing a variety of other actions which are deemed necessary in order to restore the environment. The central issue in this strategic debate is whether the costs of the environmental restoration should be borne by adding to the cost of production of the product (energy) or by various forms of subsidy. The technology exists to restore many of the environmental scars of energy extraction and acquisition; however, the one environmental impact that cannot be changed in any way is the fact that once a ton of coal, barrel of petroleum, or ton of uranium has been used to produce energy for current consumption, its value as a resource available to future generations and to other uses is forever lost. The conversion of energy from nonrenew able resources is always a net reduction of the potential man-made energy pool left in the environment.

3. Prevention of Degradation of the Environment-this strategy seeks to prevent strip mining from occurring rather than cleaning up its results. Carried to the ultimate, this strategy would be very conservationoriented. In its extreme, it would seek to minimize the nonrenewable raw materials consumed in the generation of energy. This limitation could come about by the introduction of mechanisms other than price for determining which energy demands should be regarded as legitimate. It would also seek to minimize environmental exchanges by encouraging the use of current income energy sources converted and consumed in a manner which would be the least polluting to the environment-thus reducing as much as possible the net impact of man's intervention in natural processes to acquire the energy necessary to fill legitimate needs.

Strategies Concerning Intermediate Conversion and Distribution Systems

 Economies of Scale—most intermediate conversion systems are large in scale (and are more cost efficient the larger the unit is).

Diversity of Source Material—this involves the potential for use of a number of energy raw material mixes by the intermediate conversion systems.

3. Economies of Conversion Efficiency—one important energy conservation strategy is the drive to increase the efficiency of the centralized conversion

processes. For example, if the electrical generating systems were 2/3 efficient rather than 1/3 efficient, we could reduce the amounts of raw materials consumed in generating electricity without affecting the amount of electricity consumed.

4. Economies of Delivery Efficiency: The Most Economical Way to Move the Energy to the Point of Intermediate Conversion and Then to the Point of Consumption—included are power lines, pipelines, barges, trucking, etc. More efficient transmission processes are being sought and can be expected to be developed soon.

Strategies Concerning End Point Consumption Systems

 Reliance upon Central Systems—the dominant operational strategy in most consumption units entails reliance upon large central off-site generating and conversion systems (the principal exceptions are in the area of transportation).

2. Low Cost and Abundant Energy Supplies—the dominant operational strategy of present consumption units has essentially assumed this condition. From a design standpoint, present emphasis upon low capital investment or first costs versus higher operating or life cycle costs stimulates inefficient energy consumption.

3. Higher Cost but Still Unlimited Supply of Energy—arguments are now advanced for a floating market price system which will increase the cost of energy dramatically in periods of scarcity, thus restricting demand and encouraging more supply or development of substitutes as the present "capital accounts" of nature are exhausted. This is a modified version of the present demand strategy which is based upon "economic determinism."

4. Energy Scarcity at Any Price—extra-market considerations (environmental or political issues) can affect the operation of the economy and lead to periods of temporary disequilibrium causing scarcity. During these periods, some form of allocation and conservation drive is necessary because the supplies are inadequate to the demands at any cost (or at least any acceptable cost). There is little present official indication that there is an operational recognition of the fact that an energy scarcity strategy is needed—only temporary crisis management. This belies the apparent facts which indicate that a chronic era of scarcity will exist for at least the next four to six decades—unless major strategic redirections can be achieved.

5. Degree of Pollution—there has been, since the late 1960's, increasing emphasis shifting to a nonpolluting strategy. Additional items are being added to the definition of pollution—heat into the atmosphere, noise, etc. At present, the concern rests largely with individual plants and buildings, and with the waste management

processes which could reduce effluent or at least untreatable effluent. A trend toward more macro considerations may develop as the various models of the ecology of given areas (such as metropolitan Los Angeles) evolve. These developments will generate significant impacts upon planning activities.

DEFINING THE MOST DESIRABLE ENERGY STRATEGY

Each of the foregoing strategic categories is evident to at least some degree within our economy. However, not all are of equal desirability. Those strategies which are most desirable and those which are least desirable must be defined. This can then become a guide to evaluating our overall national energy policies.

In Figure 2-2, each of the strategies discussed above is listed and tentatively ranked for its relative desirability. Clearly, the best solution would be to have a set of national energy policies with would utilize those strategies regarded as most desirable as much as possible. Of course, this cannot occur overnight, and it will probably always be necessary to have in operation some of the strategies which are classified as undesirable. However, our energy policies can be evaluated from this perspective, hoping to assure that the undesirable

operations are held to the absolute minimum, and that their relative importance will decrease in the future.

In terms of this framework, the following statements might be said to characterize the most desirable strategy:

- Maximum reliance should be placed upon natural processes from nature's current income, with a corresponding minimization of demand upon nonrenewable resources whose conversion is permanent.
- With respect to intermediate conversion and distribution systems, it might be said that the most desirable strategies lead toward more diversity of input capabilities and toward higher efficiency of both the conversion and the distribution systems.
- With respect to the consumption units, it might be generally assumed that the most desirable strategy would be one which combines directions leading from low to high efficiency, from centralized to decentralized energy systems, from "Nature's Capital" sources toward "Current Income" natural energy sources. All of these objectives would be embodied in a strategy of energy conservation.
- Environmental strategies should rely upon preventive measures, with restoration as a fall back alternative.

FIGURE 2-2: DEFINING THE MOST DESIRABLE ENERGY STRATEGY

Strategies		Least	More	Most
Strategies		Desirable	Acceptable	Desirabl
Energy So	ource.			
1.	Throughput Consumption	x		
2.	Long-Term Renewables		x	
3.	Regeneration		X	
4.	Natural Processes		•	х
Energy/E	nvironmental Exchanges			
1.	Nondifferentiated Economic Demand without			
	Regard to Side Effects	X		
2	Nondifferentiated Economic Demand with Restoration			
	of Side Effects		x	
3.	Prevent Environmental Degradation			X
Intermedi	ate Conversion and Distribution Systems			
1.	Economies of Scale			X
2.	Diversity of Source Material			X
3.	Economies of Conversion Efficiency			X
4.	Economies of Delivery Efficiency			X
End Point	Consumption Systems			
1.	Reliance upon Central Systems	X (for natur	e's capital type energ	ev)
2.	Low Cost Abundant Energy		775	X
3.	Higher Cost Unlimited Supply		x	200
4.	Energy Scarcity at Any Price	X		
5.	Degree of Pollution Minimized			x

CHAPTER III: THE CONSERVATION NEED AND POTENTIAL

The preceding chapter summarized a basic framework within which to view the nation's energy policies. This chapter shows how important conservation is. Supply/demand projections and various estimates of supply gaps are shown. Conservation potentials are estimated. It is clear that conservation must become a cornerstone of any successful national energy policy which solves the problem without reducing our activities or quality of life. While these present estimates of the conservation potential are crude, we believe that time will show them to be reasonable and an appropriate basis for setting research priorities.

ENERGY SUPPLY/DEMAND (THE CONSERVATION NEED)

It is useful to show the conservation need before looking at the conservation potential. This need is described here as an apparent unavoidable deficiency of energy supply capability relative to various levels of energy demands or needs. With the recent search for a national energy policy, many different views of both future production and supply capacity and future needs and demands have been generated. Figure 3-1 summarizes and compares various estimates of energy production and demand to 1985.

From the many estimates available, a representative set of those generally regarded as most credible has been selected, including those made by the following private and governmental agencies:

- The Lawrence Livermore Laboratory
- The Ford Foundation's Energy Policy Project
- The National Academy of Engineering
- The Federal Energy Administration
- The Energy Research and Development
 - The National Petroleum Council

A glance at Figure 3-1 will reveal the range of these estimates and will suggest that each one rests upon a different set of assumptions or views about future developments. Even the same organization will have a variety of estimates based upon different assumptions. These variations are expressed as either cases, such as case 1, 2, and 3, or as scenarios.

Before describing specific aspects of Figure 3-1 further, we shall review briefly these basic cases and scenarios.

LIVERMORE LABORATORY

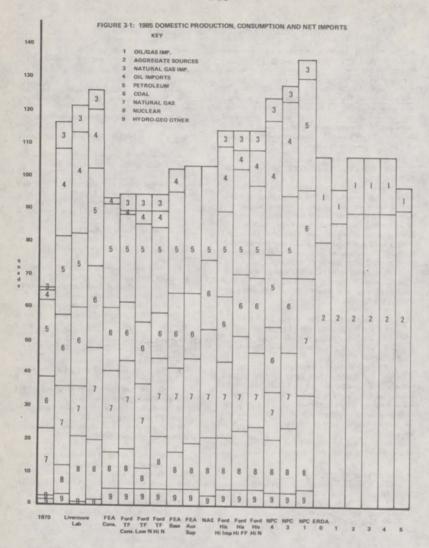
- Initial Appraisal (Taken from the National Petroleum Council data)
 - Recent levels of oil exploration, drilling activities and exploration success to continue
 - · Level of capital investment in gas development

- and drilling to remain relatively constant
- After the limit of domestic oil production is reached, remaining requirements to be satisfied by imports
 - All feasible sources of gas supply to be utilized
 - Nuclear power to be utilized to maximum extent feasible
- Coal production to rise by degree necessitated by demand
- Case 2 (Taken from the National Petroleum Council data)

 Oil and gas drilling to increase by 3.5% per year
 - High projection of oil and gas discovered per foot drilled
 - Nuclear manufacturing and installation problems to be solved quickly
 - Coal production increases at 3.5% per year
 - Synthetic fuels developed and produced at moderate rate
 - Department of Interior (Dupree/West)
 - Hydropower development to be limited by availability of sites and environmental, economic considerations
 - Introduction of better reactors in the nuclear area to allow increased nuclear outputs
 - Coal resources adequate, although problems vis-a-vis environmental and capital considerations
 - Domestic natural gas and petroleum will have to be supplemented by synthetic production, greater use of coal, or imports

NATIONAL PETROLEUM COUNCIL

- Case
- Oil and gas drilling to increase by 5.5% per year
- High projection of oil and gas discovered per foot drilled
- All new base-load generating plants ordered between now and 1985 to be nuclear
- Production of coal for domestic consumption increased by 5% per year
- Synthetic fuels developed and produced at maximum rate physically possible
- Case 3
 - · Oil and gas drilling to increase by 3.5% per year
- Lower projection of oil and gas findings per foot drilled (reflect recent actual experiences)
- Development of nuclear power at about the rate in AEC's most favorable forecast
 - Coal production increased at 3.5% per year
- Synthetic fuels developed and produced at moderate rate



- Case 4

- Recent trends in U. S. oil and gas drilling and success of such efforts to continue
- Siting and licensing problems with nuclear plants to continue
- Environmental constraints will continue to hold down development of resources

FORD FOUNDATION

Historical Growth

· Supply mix shifts away from oil and gas

 Greater role for coal and nuclear power-2/3 of growth in energy between now and year 2000

Continuing trend toward greater electrification—
40% of total energy in year 2000

Development of all major sources of energy growth

High Imports

 Possibility that major new discoveries will permit new growth in imports to U.S.

 Offshore regions developed to produce large amounts of oil at prices near current world levels

High Fossil Fuels

Rapid exploitation of fossil fuel resource base

Financial incentives to industry and resolution of environmental concerns
 Extensive offshore development and use of

advanced recovery techniques for existing wells

 Toward end of century, synthetics from coal and shale

High Nuclear

Nuclear power to substitute for fossil fuels

Technology needed to allow electricity to substitute for liquid fuels

• Increase electric utilities' share of total energy consumption

 Continuing need to develop oil and gas supplies—if unavailable, substitutes from synthetics, imports, coal

- Technical Fix

 Application of economically feasible technology to end uses of energy (conservation)

 Necessity to increase at least one major source of energy significantly above current production levels

 Large fraction of electricity used in year 2000 to come from decentralized sources—total energy systems and on-site generation—in self-sufficiency and environmental protection scenarios

Flexibility to develop alternate sources of energy

NATIONAL ACADEMY OF ENGINEERING

 Development of conservation ethic together with higher price could reduce demand to 49 to 50 MBPD by 1985 Decreases in demand from smaller cars, better insulation; in long run, savings from improved industrial process and more efficient heating and cooling

 Production levels of about 49 MBPD by 1985 feasible at high financial cost and stress on environment

 If oil and gas prices reach world levels, domestic production could be increased (including Alaska and Outer Continental Shelf) to 27 MBPD by 1985

 Advanced secondary and tertiary recovery techniques and development of fracturing methods to free gas in low-permeability fields could yield significant additional increments

 Coal production at least 1,260 million tons per year by 1985

 Coal-fired electricity plants could account for 220 Gigawatts electric of increased capacity and nuclear fission plants for an additional 300 Gigawatts electric by 1985

FEDERAL ENERGY ADMINISTRATION

Base Case

 At \$11 world prices, domestic energy demand to grow at substantially lower rates

 Petroleum production severely constrained in the short run and greatly affected by world prices in the long run

Coal production to increase significantly, but lack of markets

· Potential increases in natural gas limited

 Nuclear power to grow to 30% of total electric power generation

 Geothermal, solar and other advanced technologies not to contribute to energy requirements until after 1985

Accelerated Supply

 Federal policy to lease Atlantic Outer Continental Shelf, and tap Naval Petroleum Reserves
 At \$11 price production could reach 12 MBPD

Similar price would provide economic viability
or shale oil, production could reach I MRPD in 1985.

for shale oil—production could reach 1 MBPD in 1985

Relaxation of some environmental regulation

Energy Conservation
 To achieve savings beyond those induced by price, new standards for products and building and/or subsidies and incentives

 Possible new standards for more efficient autos, incentives to reduce miles traveled, incentives for improved thermal efficiency in homes and offices and minimum thermal standards

 Petroleum demand reduced by 2.2 MBPD in 1985

Electricity consumption reduced from 12.3
 Quads to about 11.0 in 1985

Overall reduction in demand growth to about 2.0 per cent per year between 1972 and 1985

ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

Scenario zero

Supply Assumptions

- Oil and gas production to draw on remaining recoverable domestic resources
 - According to lower estimates by the U. S.
 Geological Survey (1975) and the National Academy of Sciences
 - Without tertiary or other new recovery
- Coal and nuclear converter reactors to continue to expand to meet electricity demand, limited by ability to construct or convert plants
- Other energy sources (e.g., geothermal, hydroelectric, and urban wastes) to expand according to historic projections of existing technologies which do not reflect recognition of a serious energy problem

Demand Assumptions

- Current consumption patterns to continue with no improvement in residential, commercial, or industrial end-use and most transportation efficiencies
- A 40 per cent efficiency improvement for energy use in automobiles realized by 1980 because of a trend toward smaller autos
- Scenario 1

Supply Assumptions

- Domestic oil and gas production increased above the base case (Scenario zero) by new enhanced recovery techniques
 - Solar heating and cooling introduced
- Geothermal heat used for process and space heating
- Waste materials employed as fuels or recycled to save net energy in production

Demand Assumptions

- Residential and commercial sector technologies improved with regard to
 - The structure itself in order to reduce heating and cooling requirements
 - Improved air conditioners, furnaces, and heat pumps
 - Appliances and consumer products
- Industrial process efficiency improvements achieved in
 - Process heat and electric equipment
 - Petrochemicals
 - Primary metals
- Efficiencies of electricity transmission and distribution increased
- Improved transportation efficiencies derived from new technologies (in contrast to efficiencies from smaller vehicles) assumed for land and air transportation
- Waste heat (e.g., from electric generation)
 employed for other low-grade uses now requiring

separate energy input

- Scenario 2
- Supply Assumptions
- Substantial new synthetic fuels production introduced from
 - Coa
 - Oil shale
 - Biomass
- Enhanced oil and gas recovery levels of Scenario I included
- Under-used solar, geothermal, and waste sources included in Scenario zero not included here

Demand Assumptions

- No end-use efficiency improvements assumed
- Scenario 3

Supply Assumptions

- Electric power intensively generated from coal and nuclear power as in prior scenarios
- New technology energy sources introduced as available to generate electricity
 - Breeder reactors
 - Solar electric (wind, thermal, photovoltaics,

and ocean thermal)

- Fusion
- Geothermal electric
- A minimal contribution assumed from waste materials (as in Scenario zero)

Demand Assumptions

- Improved electric conversion efficiencies introduced
 - Widespread use of electric autos to begin
- Technologies to improve efficiency of electricity transmission and distribution implemented

Scenario 4

Supply Assumptions

- Converter reactor energy levels constrained to 200,000 megawatts electric
- Generation of electricity from coal, at the levels in other scenarios, to permit coal to be employed for synthetics
 - Additional sources of electricity to depend on
 Accelerated geothermal development (more
 - than a factor of two over Scenario 3)
 - Accelerated solar development (a factor of two over Scenario 3)
 - Fusion as in Scenario 3
- Solar and geothermal heating used (as in Scenarios I and 3)
- Synthetic fuels produced from coal, shale, and biomass at the level of Scenario 2

Demand Assumptions

- Industrial efficiency aspect of conservation scenario (Scenario 1) included
- Electric transmission efficiencies not included, as electricity use grows too slowly to justify changes

- Scenario 5

 Combination of all major energy packages, including nuclear, commercialized (i.e., improved enduse, synthetic fuels, and electrification)

 Specific inputs for this scenario and those previously summarized in scenarios zero through 4

Summation of Key Points in Figure 3-1

Looking now at Figure 3-1, it is evident that several of the demand estimates derived since the embargo are substantially lower than those prior to the embargo. This reflects the increasing prominence of conservation as the nation has searched for a national energy policy. However, none of the estimates varies substantially from the pre-embargo production capabilities, which were already based upon a rather

optimistic and rapid increase in domestic production capa-

The "import line" drawn through the bars shows that almost all estimates will require imports, and what might be regarded as the more "reasonable" supply estimates require significant imports.

Thus, a chronic and serious supply deficiency will exist in this nation beyond 1985 and probably well into the next century, even under the most optimistic assumptions about new technological developments for increasing traditional supplies or deriving alternate supplies to be distributed through the centralized wholesale type of energy systems.

This deficiency will be of such magnitude as to require either drastic measures to curtail our consumption of energy or such substantial imports as to cause serious economic problems for the entire U. S. economy and for every citizen.

Most of this "import impact" or "restriction impact" could be avoided if a high priority, effective national program of energy conservation is developed. The conservation need is real, urgent, and will exist for a long time. The next section shows that the effective potential is also available.

THE CONSERVATION POTENTIAL

Some references to the potential of conservation are contained in the earlier discussion of the various supply/ demand scenarios. However, the conservation potential must be examined in greater depth.

Conservation is discussed under a wide variety of concepts. To some, conservation results when individuals are forced to use less gasoline because prices become so prohibitive their freedom of action is restrained. To others, conservation occurs if, again due to either price or absolute scarcity, individuals are forced, despite their feelings of comfort, to adjust their their thermostats to lower levels in winter and higher levels in summer. Examples could go on and on.

But as stated at the outset, this is not the form of conservation which the National Advisory Council on Research in Energy Conservation regards as acceptable. These types of approaches could be considered enforced behavioral modifications. While some modifications of our individual and collective behavior are undoubtedly to be desired, the Council strongly believes that such approaches in national policy should be reserved for short-term emergency requirements. From a long-term strategic policy perspective, these forms of coerciveness, which constrain our individual activity, freedom, quality of life, and economic development, are not desirable. Moreover, history shows them to be quite unreliable as a means of long-term sustained control. Eventually, for example, higher prices for energy may be compensated for by increased inflationary pressures to increase earnings to such a point as to afford the additional energy. The consequences of this form of conservation imperative are economically, politically, and socially costly in both the short run and the long run. Thus, we contend that they should be the last line, not the first line, of our national policies to achieve energy conservation. Unfortunately, our conclusion must be that present energy policies place them in the first line. More is said on this point later

What then is left to the "energy conservationist"? As our definition in Chapter One indicates, there are at least two additional avenues open: (1) reduction of waste through increased efficiency of our systems for consuming energy, and (2) substitution of energy collected from natural processes occurring at or near the point of consumption or use which do not involve either a drain upon natural resources or a degradation of environmental quality.

Clearly, these criteria cannot be met in every area immediately. but they can be met in many areas. The resulting savings will be more than equal to the amount of energy flowing from any traditional supply system, and enough to soften the supply gaps so that they produce fewer hursh impositions upon freedom of action, quality of life, or economic development.

A first step in defining the conservation potential is to estimate the relative efficiency of our existing energy systems. Such estimates are not plentiful. They exist in accurate form only as fragmented pieces of the overall puzzle. For example, adding increased insulation will decrease heat loss by a given amount. Conversely, the same treatment also reduces heat absorption. Therefore, if one wishes to use walls as a thermal conductor, less insulation is wise. Only if it is desirable for the wall to become a thermal barrier is more insulation the answer. As this example shows, even in as simple a problem as the wall of a building, the calculation of efficiency must be an individualized analysis which will differ substantially with function, location, orientation, and a variety of complex interacting characteristics of terrain, climate, and human aesthetics and purposes.

As other examples of known levels of efficiency, it is possible to estimate with reasonable reliability the amount of energy lost in centralized electrical generation, conversion, and distribution systems. The energy efficiency limitations of the internal combustion engine and other means of powering

transportation under varying circumstances also can be estimated with reasonable accuracy.

However, sufficient data are not available to permit adding up the individual pieces to get the total overall or net efficiency of our nation's energy systems. Nor are there adequate representative samples of all such energy flows to permit an accurate "blow up" by multiplying the typical or the average case times the total number of such cases within our society, as is done with many scientific models which are depended upon for accurate national estimates

In working with a combination of data and judgment, there have been attempts to estimate the overall efficiency of our energy systems. Two such attempts were made by scientists at the Lawrence Livermore Laboratory at the University of California and by Dr. Earl Cook of Texas A&M University. These estimates traced the flow of energy through the system, assigning unaccounted for energy as waste. The reasonableness of this figure was then doublechecked against the available specific detail data which can be used as "suggestive validation" of the reasonableness of the overall estimates of energy used versus energy lost.

Relating these estimates to the framework developed in the preceding chapter, Livermore Lab estimates that the overall waste (unused energy) in 1970 was 51% of all energy produced. Dr. Cook's estimates within the same framework for 1971 conclude that the overall waste is nearer to 64%.

(See Figures 3-2 and 3-3.)

Thus, our estimate of the conservation potential begins with what may at first seem unbelievable: at least as much energy can be obtained through increased operational efficiency as was used in 1970. Put another way, our effective consumption could double without any increase in production if just operational waste could be eliminated. This does not include behavioral changes, which would produce additional savings.

Of course, 100% efficiency is impossible, even theoretically. Therefore, a more detailed estimate is necessary of what portion of this waste might be realistically

eliminated.

The Ford Foundation studies mentioned earlier contained estimates of what could be done by aggressive application of energy saving technology to projected consumption if historical patterns continue. If unrestrained growth continued at past rates, the total consumption would grow from 72 Quads (Quadrillion BTU's) in 1972 to about 115 Quads in 1985 and 183 Quads in the year 2000. This could be reduced to 96 Quads in 1985 and 118 Quads in the year 2000 by conservation measures, a savings of about 16% of total consumption in 1985 and 35% in the year 2000. Put another way, within just over two decades, nearly as much energy as was consumed in 1972 could be saved through increased efficiency. Even if prices and the value of the dollar remained constant at 1972 levels, this efficiency would be valued at about \$100 billion for just the single year 2000. If realized at an even annual rate between 1975 and the year 2000, the cumulative value of such savings, in 1972 dollars and prices, would be more than \$1,250 billion

In Volume I of a more recent report, A National Plan for Energy Research Development and Demonstration: Creating Energy Choices for the Future, the newly formed Energy Research and Development Administration has estimated that improved efficiencies in end-use energy systems could reduce the annual growth rate of energy consumption to less than 2%, resulting in a 25% reduction in consumption in relation to the "business as usuai" approach by the year 2000. This tends to endorse the same estimated potential developed in the earlier Ford Foundation work.

The ERDA report considers five basic scenarios and concludes that of all of the possibilities considered, improved end-use efficiencies would produce the most dramatic reduction in energy demand over the short to intermediate term. Thus, in this report, ERDA assigns near term conservation technologies the highest priority, ranking them with research, development, and demonstration technologies for

generating alternative sources of energy.

However, while the report states such equality, it will be seen later that the plan does not seem to achieve it; at present, the operational strategy continues to remain primarily oriented toward increasing the supply of energy. These supply-oriented innovations are essential, but no more so than are effective conservation measures.

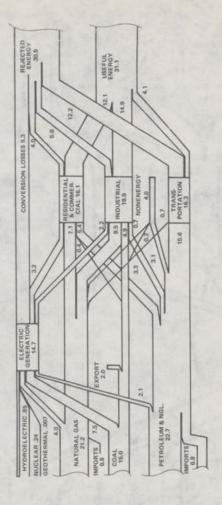
From this backdrop of the overall conservation potential, one needs to know where such savings lie and which areas should receive priority attention. This requires an examination of the potential within each of the consuming sectors. However, before this further exploration, a word of caution should be advanced about one line of argument which is being heard in support of conservation.

A Word of Caution. Many critics of our energy policies assert that the United States is excessively wasteful of energy because it uses more energy per capita and more energy per dollar of GNP than any other nation. These data are cited as evidence to conclude that consumption of energy can be easily reduced without a deleterious effect upon economic growth and development. While sharing, at least to some degree, this latter conclusion, the Council does not believe that these per capita comparisons provide a reliable justification for the conclusion or a reliable basis for policy actions.

Figure 3-4 summarizes selected comparisons in terms of per capita consumption for the world as a whole and for the ten leading energy consuming nations. Allowing for the difficulties associated with incomplete data from some nations and with equating monetary units, it is clear that the U. S. economy consumes more energy per GNP dollar and more energy per capita.

In addition, in 1974, three European countries-Sweden, Switzerland, and West Germany-exceeded or equalled U. S. per capita GNP with a per capita energy use figure of about

FIGURE 3-2: U.S. ENERGY FLOW -- 1970



All values \times 10 $^{1.5}$ Btu (2.12 \times 10 $^{1.5}$ Btu = 10 6 bbl/day oit) Total energy consumption = 67.5 \times 10 $^{1.5}$ Btu

Source: A. L. Austin and S. D. Winter, U. S. Energy Flow Charts for 1950, 1960, 1970, 1986, 1985, and 1996, Livermore, Cal.: Lawrence Livermore Laboratory, 1973

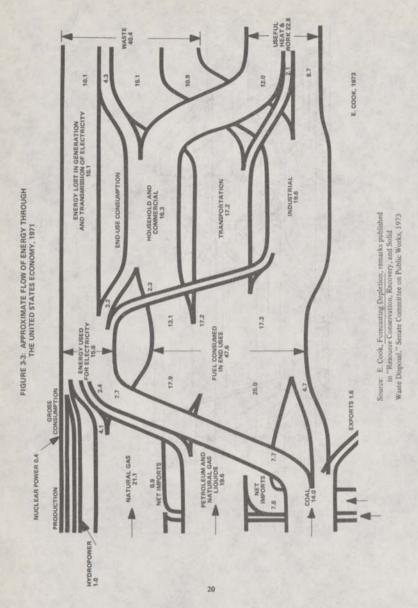


FIGURE 3-4: WORLD ENERGY CONSUMPTION AND GROSS NATIONAL PRODUCT, 1972

		NATIONAL C	NATIONAL CONSUMPTION		PER CAPITA	PER CAPITA CONSUMPTION	
	ENER	ENERGY EQUIVALENT	ENT	GNP	ENERGY	GNP	
COUNTRY	Coal	BTU's	IIO				SGNP/
	Billions of tons	Ouads	Billions of bbis.	Sillions	Barrels	Dollars	BBL. OIL
World	8.17	212.3	36.6		10.3		
United States	2.67	69.5	12.0	1,151.8	57.3	5,515	0.96
USSR	1.30	33.8	5.8	NA	23.5	NA	NA
People's Republic of China	0.49	12.7	2.2	NA	2.8	NA	NA
Japan	0.38	6.6	1.7	292.0	16.1	2,757	171.8
West Germany	0.37	9.5	1.6	257.0	26.6	4,101	160.6
United Kingdom	0.33	8.7	1.5	162.0	26.7	2,877	108.0
Canada	0.26	6.7	1.2	102.5	53.1	4,704	85.4
France	0.24	6.2	1.1	197.0	20.5	3,810	179.1
Italy	0.17	4.3	0.7	118.2	13.8	2,170	168.9
Poland	0.17	4.3	0.7	NA	22.5	NA	NA

60% of the American level. Looked at from this perspective, it appears that the United States could effect the greatest savings through energy conservation with the least amount of economic disruption.

With only 6% of the world's population, the United States uses approximately a third of the world's energy. Given such a discrepancy between the number of individuals and the amount of energy consumed, it is argued that large portions of the energy used in the United States are devoted to nonessential purposes and that the level of consumption is neither economically nor morally justifiable.

These comparisons are invalid for reasons other than statistical problems. For example, the U.S. economy has significant extraction industries, which are energy-intensive. There are no estimates of the amounts of energy which each nation imports in the form of goods, materials, and services versus what it exports in these same forms, versus the net which it consumes within its own boundaries. The U.S. economy hardly can be compared to an economy such as that of Japan which imports nearly all of its raw materials and is therefore not charged, in these calculations, with the energy content of such materials. Nor is our economy comparable to a more labor-intensive economy such as China, where huge amounts of energy are derived from human labor and hence not included in these energy calculations. The geography of Japan and European nations is different from that of the United States. Less transportation is required, partly because there is less space encompassed by the internal economy. These brief points should serve to illustrate the spurious nature of making too much of energy variations per capita and per GNP dollar. A much more sophisticated analysis would be required to render this line of argument a valid basis for either evaluating current policies or formulating new ones.

Conservation Potentials in Centralized Electrical Generation
One of the areas where wasted energy is most prevalent
is the loss in conversion and distribution of energy channeled
through centralized electrical plants. Only about thirty-four
or thirty-five per cent of such energy ever reaches the point
of use where still more of it may be lost.

Conservation of this electric "seepage" or loss could occur in three basic ways: 1) increasing the efficiency of the electrical generation, conversion, and distribution systems; 2) reducing the amount of centrally generated electricity which is consumed; and 3) recovering the heat discarded in the generating process and using it as a valuable byproduct.

It is clear that three units of energy are saved for every unit of electrical energy which is not needed. Thus, reduction of energy loss in end-use operation which results in a reduced demand for electricity yields not only the savings within the consuming area but additional savings from generator fuel not required.

This makes it tempting to conclude that it would be better to transform the nation's electrical system to a series of individualized generators, possibly run by diesel or some other form of fuel. Such systems are in use in some areas now, primarily as auxiliary or standby generators. But engineering history shows that the overall efficiency of these traditionally fueled decentralized systems is less than more conventional systems. They require more total investment for the amount of energy they can generate, they require more maintenance costs, and the efficiency of the internal combustion generators is lower than that of the central electrical generating plant.

However, there are now opportunities opening to supply a large percentage of low grade energy from solar collectors and conversion systems operating on site. Such systems can seldom provide all of the energy needed, and thus require some form of reserve source upon which to draw. But this does introduce a new dimension to the truditional argument against decentralized generating capabilities.

There is much discussion of the problems of "peak load" as a part of the energy conservation dialogue. This essentially refers to the fact that the electrical generating capacity has to be equal to the highest demand placed upon it within a year. On the average, this means that much more electrical generating capacity must be built than would be required if the demand load were made uniform. We wish to point out, however, that this is primarily a concept of increasing the financial efficiency of the centralized electrical system, not the energy efficiency. Thus, we would not include these measures in our concepts of energy conservation. Once this is said, we have excluded much of the contemporary analysis dealing with improvement, research or development within the centralized electrical industry.

There are three basic ways to achieve energy conservation in the sense of seduced energy flows:

- Increase the conversion efficiency of the electrical generating plants.
- Increase the distribution efficiency of the transmission lines.
- Decrease the demand for electricity through increasing the efficiency of the consumption units or through substituting at the point of consumption conversion from renewable energy sources such as solar and wind.

As will be seen later, the nearest, highest return per investment dollar seems now to be in the third area.

Estimates of the conservation potential under the third category are contained as a portion of the following sections dealing with each of the end-use sectors. The potential for the first two categories, covering the internal efficiencies within the electrical system itself, are very sketchy. The FEA's Project Independence Report assigned an estimate of approximately 3.25 Quads by 1985 if world oil prices are at \$11 per barrel. However, substantially more research into this area is needed even to begin to estimate the conservation potential and ways to realize it.

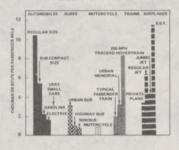
Conservation Potentials in Transportation

It seems that most national attention regarding energy conservation is centered upon the transportation sector. The following portion of this chapter will cause the careful reader to wonder why this is the case, since far more technologically, economically, socially, and politically feasible alternatives exist to achieve the same objectives in other sectors as well-particularly in the built environment. One can only speculate on the reasons for this emphasis, but it may stem largely from some combination of the following factors:

- 1) The energy crisis surfaced in the form of an oil embargo and was most dramatically implanted in the minds of people (even sophisticated national policy analysts and policy-makers) through long gasoline lines at automobile service stations. Since automobiles are so obviously linked with petroleum, it is a natural connection to assume that the oil problem could be resolved if dependence upon the automobile could be substantially reduced or even eliminated.
- 2) The automobile has been quite visible in public debates as a major national problem for reasons such as environmental quality, urban transportation efficiencies and the discriminatory nature of inadequate public transportation which impacts inordinately upon the poor.
- There are well-known inefficiencies in the contemporary internal combustion engine.
- The transportation sector is the least efficient end-use category when taken as a whole. (See Figures 3-2 and 3-3).

With this national attention focused upon it, the transportation sector has been the subject of a great deal of analysis. Much of this analysis centers upon the relative energy efficiencies of different modes of transportation. For example, as is shown in Figure 3-5, the thousands of BTU's per passenger mile vary widely depending upon the type of vehicle used.

FIGURE 3-6: TRANSPORTATION ENERGY CONSUMPTION OF VARIOUS MODES



	Mode	Passenger Miles Per Gallon	Number Pas- sen- gers	Thousands BTU'S Per Passenger Mile
Autos:	Regular Size	12	1.3	10,4
	Sub-compact	23	1.3	5.4
	Very Small (gasoline)	59	1.3	2.1
	Very Small (electric)	78	1.3	1.6
*Buses:	Urban bus	40	12	3.1
	Highway bus	140	22	0.9
	Minibus	175	7	0.7
*Motorcycle: *Trains:		160 65	300	0.8
	Hovertrain Urben Monorail	15 40	48	8.3
*Planes:	Private plane	37	3	3.4
	Regular jet (DC-8)	20	80	6.3
	Jumbo jet (8-747)	30	200	4.2
	S.S.T. (Mach 2.7, U.S.)	11	150	11.4

*Source: Rice, Richard A., 1972, "Energy Efficiencies of the Transport Systems," a pager presented before the Society of Automotive Engineers at the International Automotive Engineering Congress, Detroit, Michigan, January, 1973.

These relative energy efficiencies per passenger mile take on added significance when integrated with the trends in vehicle use. Figure 3-6 summarizes these historic patterns. By 1970, automobiles accounted for 54% of the energy used in the transportation sector, trucks for 21% and airplanes for nearly 11%. These three most popular modes of travel account for approximately 86% of total energy used in transportation, and of course they also consume more energy per passenger mile than any of the other vehicles.

Accordingly, energy conservation in the transportation sector can be achieved by some combination of the following:

- Reduce the per passenger mile energy consumption by automobiles, trucks, and airplanes. Present proposals call for achieving energy savings by reducing the size and weight of autos to compact models and converting trucks to diesel fuel, which gives slightly more efficiency. There are, however, proposals centered around increasing the efficiency of existing styles of vehicles through improved internal combustion engines or through alternatives to the internal combustion engine as the source of power. One such alternative is the electric car. However, conversion to electrically powered vehicles will require three units of energy for each unit delivered to the vehicle plus the amount of loss within the vehicle operating itself.
- 2. Change the method or mode of transportation from energy-intensive per passenger mile vehicles to railroads, mass transit, bicyles, etc. Several estimates of the energy conservation potential of these approaches have been made. Four of them, which are representative of the ranges, are as follows:

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FIGURE 3-6: HISTORICAL ENERGY CONSUMPTION PATTERNS FOR TRANSPORTATION

	al Trat	

								Total	
	Total				Waterway			Energy	Average
Year	Traffic	Air	Truck	Rail	& Pipeline	Auto	Bus*	(1012 Btu)	EI
				Inter-C	City Freight Traff	ic			
1950	1350 ^b	0.02	13	47	41			2700	2000 ^d
1960	1600	0.05	18	38	44	10		1800	1100
1970	2210	0.15	19	35	46	-	-	2400	1100
					ity Passenger Traf				
				Inter-C	ity ressenger trai	THE			
1950	500 °	2	-	7.	-	86	5	1700	3400*
1960	800	4	-	3	-	91	2	2700	3400
1970	1120	10	-	1	-	87	2	4300	3800
				Urba	n Passenger Traff	ic			
1950	310°	-	-	-	-	85	15	2100	7000°
1960	430	-	-	-		94	6	3300	7700
1970	710	-	-	-	-	97	3	5700	8000

^{*}Inter-city bus or urban mass transit.

Source: Eric Hirst, Energy Intensiveness of Passenger and Freight Transport Modes: 1950-1970, Oak Ridge National Laboratory, 1973.

^bBillion ton-miles.

⁶Billion passenger-miles.

d Btu/ton-mile.

^{*}Btu/passenger-mile.

Office of Emergency Preparedness	4.6 Quads by 1980
National Academy of	8.8 Quads by 1985
Engineering Project Independence	2.8 Quads by 1980-1990
Ford Foundation Energy Policy Project	7.0 Quads by 1985

However, most of these savings are achieved only through imposing differing life-styles—smaller cars, public transportation (which is largely nonexistent in many areas for many travel needs), use of rail versus air travel, etc. These methods fall outside this Council's definition of conservation potential.

The technological forecasts for energy conservation through increased efficiency of current vehicular form and style are not encouraging; thus, we conclude that the "desirable energy conservation potential" of this sector is very high only if substantial technological developments occur, developments which seem to be years if not decades away.

At this point it should be emphasized that despite the close association in the public mind between transportation and petroleum, the entire sector consumes only about half of the petroleum used within the United States. Thus, even if the objective is defined as petroleum rather than energy conservation (which, in reality, is the dominant operational focus of the present search for national energy conservation and much of the national energy policies as a whole), there is still at least as much potential outside the transportation sector as within it.

Energy Conservation Potential in Industrial Uses

Industry is the largest consumer of energy. This consumption is heavily concentrated in a few very energy-intensive manufacturing or industrial areas. Six major groups-chemicals; primary metals; petroleum and coal products; paper and allied products; stone, clay, and glass products; and food and kindred products-account for 80% of the fuels and electric energy used by industry for heat and power in 1971. (See Figure 3-7)

The search for conservation in industry has tended to concentrate upon these high users.

At least two efforts give some clues of the conservation potential. One of these is a cooperative program between the Federal Energy Administration, the Department of Commerce, and key energy using industries, in which the various industries have established voluntary energy efficiency improvement goals for 1980. The results thus far for the first group of industries to report energy savings under the voluntary program are as follows:

Industry (Trade Association)	1980 Goal	Energy Efficiency Improvement
ALUMINUM (The Aluminum Association Inc.)	10%	6.5%*
CEMENT (Portland Cement Association)	10%	1.6%
CHEMICALS (Manufacturing Chemists Association)	15%	7.5%
PAPER (American Paper Institute)	10%	2.5%
PETROLEUM REFINING (American Petroleum Institute)	15%	7.8%**
STEEL (American Iron & Steel Institute)	10%	2.7%

*Denotes 1975 vs. 1972 baseline, all others are 1974 vs.

**Denotes BTU/unit input, all others are BTU/unit output.

On the basis of this sampling, one might expect the potential for the industrial sector to be at least 10% and probably 12% or so by 1980, with still further reduction possible beyond that point.

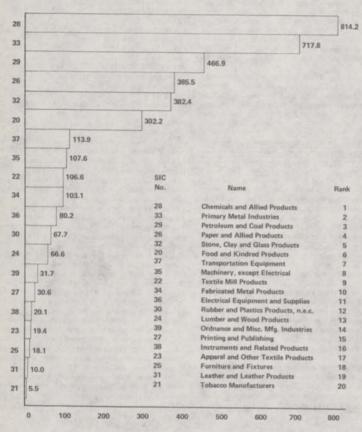
From another perspective, the amount of energy consumed in relation to the output of the industries has also been estimated. This is an important step, because in a growing economy where industries are increasing their output, significant conservation may be hidden because the gross demands continue to rise. Thus, the relationship of energy consumed to value-added factors has been developed by the Conference Board (See Figure 3-8).

The Conference Board study estimated that if energy use rose in proportion to value-added between 1971 and 1980, 5 Quads (2.4 MBPD) more in purchased energy (plus 1.5 Quads of captive energy) would be used by the manufacturing sector in 1980 alone. Without the savings estimated by this study, energy absorbed (including captive) would be 23% higher than the projected amount.

The specific areas in which long-term improvement in energy efficiency seems most significant are: steam generation, heat recovery, industrial processes, and recycling. However, many technological advances in a variety of technical fields may introduce further opportunities for conserving the amount of energy used per production unit.

The overall conservation potential for the sector as a whole has been estimated by several groups which are represented by the following:

FIGURE 3-7: ENERGY CONSUMPTION IN THE MANUFACTURING INDUSTRIES, 1971



1971 Net Energy Demand, Kwh (equiv.) x 10°

Source: Energy Conservation Research: Proceedings of the NSF/RANN Conference on Energy Conservation Research at Airlie House, Virginia, 1974

FIGURE 3-8: RATES OF CHANGE OF RATIOS OF ENERGY CONSUMED TO VALUE ADDED, HIGH-ENERGY-USING MANUFACTURING GROUPS, 1954-1980 (per cent per year compounded annually)

	1964	1967	1975	1967
	to	10	to	to
	1967	1975	1980	1980
Purchase by all manufacturing plus energy				
produced and consumed in the same establish-				
ment ("captive consumption") by				
SICs 2911 and 3312	-1.6	-1.8	-2.4	-2.0
Purchased by all manufacturing	-1.3	-1.5	-2.1	-1.8
			***	1,0
By six high-energy-using 2-digit groups				
Food and kindred products (SIC 20)	-1.8	-0.9	-0.5	-0.7
Paper and allied products (SIC 26)	-0.8	-0.6	-4.0	-1.9
Chemicals and allied products (SIC 28)	-3.1	-2.1	-2.7	-2.3
Petroleum and coal products (SIC 29)	+2.1	-0.9	-2.9	-1.6
Stone, clay, and glass products (SIC 32)	-1.7	-0.7	-1.2	-0.9
Primary metal industries (SIC 33)	-1.2	-1.3	-0.6	-1.0
Average of six groups	-1,2	-1.1	-1.8	-1.4
By all other manufacturing	-1.0	-0.9	-1.6	-1.1
Captive consumption				- 44
By petroleum refining (SIC 2911)	-3.8	-3.3	-4.5	-3.7
By blast furnaces and steel mills (SIC 3312)**	0.0	-1.4	-2.4	-1.8
Addendum				
Purchased by petroleum and coal products				
(SIC 29) plus captive by petroleum				
refining (SIC 2911)*	-1.0	-1.9	-3.5	-2.5
Purchased by primary inetals (SIC 33)				
plus captive by blast furnaces and steel				
mills (SIC 3312) 2	-0.8	-1.3	-12	-1.3
Purchased by six groups plus captive by	7 000			
SICs 2911 and 3312 b	-1.4	-1.4	-2.1	-1.7
			-	

⁶The indicated energy was divided by value added in the 2-digit group.

Note: The decline of purchased energy per unit for primary metals and for all manufacturing may be overstated from 1954 to 1967; similarly, captive energy per unit for primary metals, shown as unchanged, may have fallen during the same period; see Note to Table 1-1.

Source: computed from Tables 1-1, 1-2, and 1-3.

Source: The Conference Board, Energy Consumption in Manufacturing: A Report to the Energy Policy Project of the Ford Foundation, Cambridge, Mass.: Ballinger Publishing Company, 1974

^bThe indicated energy was divided by value added in the 6 groups.

Office of Emergency Preparedness	5.2 Quads by 1980
National Academy of Engineering	5.0 Quads by 1985
Project Independence ¹	9.2 Quads by 1980-1990
Ford Foundation Energy Policy Project ¹	5.6 Quads by 1985

(1 Value-added method)

Savings similar to those projected above would approach one half of the amount of petroleum which the United States imported in 1973.

There is a tendency among many analysts to feel that the industrial sector will "take care of itself" and that it has the capacity and the motivation to initiate energy conservation measures in response to rising costs. This may be an unclear picture. There are many factors operating within the business environment which might make it less flexible and dynamic than is supposed. The principles of "sunk costs" come into play, in which major revisions to present industrial plant and equipment may not always be made in terms of today's technological and economic trade-offs, but rather in terms of what has already been put into place. Such situations may have to await some amortization period before they again become "economically feasible." A variety of tax and other business operating considerations are also operable, many of which make it unlikely that price increases will not be "pushed through" as added costs of production rather than seen as stimulants to energy conservation.

Thus, the Council believes that the industrial sector, which clearly has a valuable conservation potential, should be specifically studied in detail and appropriate technical and institutional developments should be worked out to make sure that this potential is realized.

Energy Conservation Potential in the Built Environment
The built environment is related to the consumption of

energy in many ways:

Residential, commercial, and industrial buildings consume energy in their operations as buildings.

- Particular forms of energy are often determined for years by the selection of which type of fuel will be initially installed for heating or air conditioning in buildings.
- Different building materials require substantially different quantities of energy in their production.
- Psychological and behavioral criteria determine many aspects of building demands. For example, more lighting has been shown to have "good" effects on morale, on crime rates, and on the quantity of sales of merchandise.
- Many transportation needs are determined by the spatial relationships among buildings, and among alternative land uses.
- The location of man's built environment generally determines where the majority of the economic

and industrial development will occur; thus, companies build where there is a labor force and community structure to support the needs of the operation.

The energy conservation potential of the built environment entails not only looking at buildings themselves as energy consuming units, but also looking at how their design, orientation, and location affect other aspects of energy consumption, particularly transportation.

There are no good estimates of the overall potential energy savings which would accrue from different land use patterns (for example, returning to the clustering of self-contained communities in which work, play, schooling, residence, and shopping are within walking distance of one another).

Similarly, while it has been suggested that substantial savings would accrue from constructing more town houses and multiple family residences, such savings will depend upon public acceptance of changing life-styles and may not be realized.

There are, however, more reliable estimates of the amount of energy which can be saved in operation of buildings. These calculations generally stress increased thermal efficiency of exterior walls and ceilings, more efficient operation of mechanical systems (heating, cooling, lighting, etc.), and reduction of some demands, such as lowering thermostats in winter to a level consistent with physical need rather than psychic or "comfort need" and reducing levels of lighting.

Following these lines of analysis, four separate studies have estimated the potential energy savings which could be derived in building operations:

Study	Quads	Date
Office of Emergency Preparedness	4.8	1980
National Academy of Engineering	5.0	1985
Project Independence	2.0-6.0	1980-1990
Ford Foundation Energy Policy	1.0	1985
Project Project	1.0	1985

An alternative concept, called "Energy Efficient Buildings," also has been outlined. This concept takes into account several factors:

- Buildings literally sit in a sea of natural energy from the sun, wind, and other sources, little of which is captured or converted into energy needs of the buildings.
- Virtually all energy demands for building operations are for low intensity energy, i.e., energy which is well within the range of present technological capabilities for converting much of the natural energy especially solar and wind—into useful energy for the building.
- Thus, the building can be a producer of energy as well as a consumer.
- There are many ways in which heat within the building's subsystems can be recovered into the energy systems of the building.

 There are many ways to reduce the energy demands by increasing the energy efficiency of design, construction, mechanical systems, and maintenance.

Note that only this latter dimension of energy conservation figures prominently in the calculations of conservation potential discussed above.

An energy efficient building may be defined as one which imports as little energy as possible and which exports as little as possible environmental pollutants.

Energy efficiency can be realized through two interrelated processes:

- Reducing the demand for energy as much as is feasible through energy efficient design and operation.
- Supply as much of this demand as is feasible by recycling energy within the building's subsystems and by converting natural energy flowing around it. Note that this conversion of natural energy flowing around the building requires no nonrenewable natural resources, nor does it impair natural processes.

This relatively simple reconceptualization of the relationships between buildings and energy systems dramatically increases the potential for energy conservation in buildings.

The above concepts are discussed at greater length in two reports by the American Institute of Architects, "Energy and the Built Environment: A Gap in Current Strategies" and "A Nation of Energy Efficient Buildings by 1990," Following this analysis through, the AIA has estimated that if all new buildings were designed to be energy efficient from the beginning, they could save at least 60% of the energy which they would otherwise require from some centralized supply system. In addition, if older buildings were converted to an energy efficient concept, they could reduce their energy demands on central systems by at least an average of 30%. None of these savings would require behavioral change,

discomfort, or a restriction of "psychological well being" derived from traditional approaches to living and working in buildings.

It has been estimated that if we began in 1975 to build all new buildings to be energy efficient and to convert old buildings at an even rate of about 7% per year, that within just fifteen years (by 1990) we could be saving over 12.5 million barrels of oil per day or 25 Quads of energy per year. Moreover, those savings are cumulative. They begin the first year with 1.7 Quads and progress each year to the 1990 potential.

According to one authoritative estimate, this is an amount of energy equivalent to that which could be produced in 1990 from either domestic petroleum, nuclear power, coal, or both domestic and imported natural gas.

In recognition of this near term opportunity, and of the relatively less difficult technical, political, and economic issues associated with its realization, the Council has devoted its priority attention in this report to developing additional ideas and recommendations in this area.

One final point is appropriate: these estimated savings do not begin in any way to tap the potential which accrues from using less energy-intense building materials or reducing transportation requirements by changing land use patterns and spatial relationships.

SUMMARY

In summary, in terms of the definition of desirable energy conservation developed in Chapter 1, it seems clear that the nation can more than make up for the projected domestic supply deficiencies if the potential of energy conservation can be achieved. The estimates discussed in the preceding sections are summarized in Figure 3-9.

FIGURE 3-9: SUMMARY OF CONSERVATION POTENTIAL ESTIMATES

Sector	Study	Savings (Quads)	Date
Transportation	Office of Emergency Preparedness	4,6	1980
	National Academy of Engineering	8.8	1985
	Project Independence	2.8	1980-1990
	Ford Foundation	7.0	1985
Industry	Office of Emergency Preparedness	5.2	1980
	National Academy of Engineering	5.0	1985
	Project Independence	9.2	1980-1990
	Ford Foundation	5.6	1985
Residential-	Office of Emergency Preparedness	4.8	1980
Commercial	National Academy of Engineering	5.0	1985
	Project Independence	2.0-6.0	1980-1990
	Ford Foundation	1.0	1985

CHAPTER IV: PRESENT ENERGY CONSERVATION RESEARCH POLICIES AND ACTIVITIES

INTRODUCTION

The previous chapter showed the opportunities for energy conservation. Whether these opportunities will be captured and over what time span depends to a large extent on adequate research and the practical applications flowing from it. This chapter reviews present and proposed energy research programs and summarizes the extent of national efforts (at least as manifested by research) to incorporate energy conservation into the fabric of energy policy.

As Figure 4-1 shows, energy research funding was insignificant as late as 1972. Then, between 1974 and 1975, energy development and conversion funding spurted 74 per cent and energy research spending advanced to fourth place among fourteen general R&D functions. By 1975 energy was demanding 5.1 per cent of the federal budget, up from 2.1 per cent in 1969.

A breakdown of federal energy spending for the 1969 to 1975 period is presented in Figure 4-2. Although the percentage expended for nuclear research declined from nearly 90 per cent in 1969 to slightly less than 60 per cent in 1975, it still heavily dominates the field, representing over twice the funding for any other component of energy research and development. Most of the rest of the increase in research expenditures from 1969 to 1975 went toward tripling research in the areas of fossil fuels.

Research support for solar energy was initiated in 1972 and grew rapidly from its low initial base. The same trend was evident in spending for geothermal energy. In the case of energy conservation research, for practical purposes funding did not begin until 1974 and generally lagged behind obligations for other, longer-established programs.

Thus, long-standing nuclear programs and a more recent expansion of research on fossil fuels with some new alternative sources dominate federal research and development initiatives in the field of energy. This supply-oriented emphasis overwhelmingly defines our basic national strategy refill the energy supply lines by further exploitation of fossil fuels and rely upon nuclear energy as the replacement before these nonrenewable resources are exhausted.

SPECIFIC ENERGY CONSERVATION RESEARCH PROJECTS

Federally Funded

As shown above, the federal support of energy conservation research began just a few years ago. Even though the effort is small, it is still useful to look at the details. The section outlines the energy conservation research projects supported by federal funds obligated in fiscal years 1973, 1974, and part of 1975.

Figure 4-3 summarizes the number of projects by funding agency.

FIGURE 4-3: GOVERNMENT SPONSORED R&D PROGRAMS IN ENERGY CONSERVATION

NSF	58	\$ 5,516,312	(2 unknown funding)
Commerce	28	4,081,400	(1 unknown funding)
HUD	4	1,427,100	A CONTRACTOR OF THE PARTY OF TH
FEA	5	960,000	
Interior	9	954,806	
Defense	10	55,600	(8 unknown funding)
Transportation	4	40,000	(3 unknown funding)
GSA	1	15,000	
NASA	7		(7 unknown funding)
EPA	2		(2 unknown funding)
HEW	1		(1 unknown funding)
	129	\$13,050,218	24 unknown funding

In terms of both number of projects and dollars expended the National Science Foundation played the most important role. However, during this period the Federal Energy Administration was only beginning to operate and the Energy Research and Development Administration had not yet been established. ERDA can be expected to play the dominant federal role in the future.

These 129 research projects can be classified into a framework generally compatible with that developed in Chapter II. Some variation is necessary to accommodate the structure of research as it is actually being carried out. This classification structure is as follows:

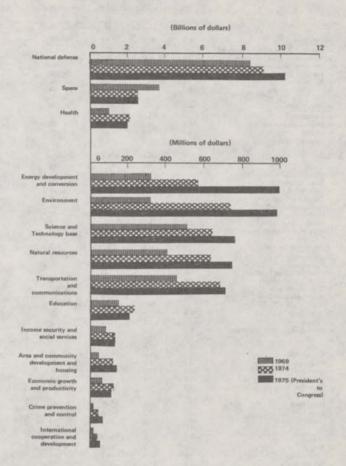
Resource Acquisition and Processing Generation/Conversion/Transmission End-use

- 1. Transportation
- 2. Industry
- 3. Built Environment Alternate Sources/Systems Economic/Policy Research Information Exchange

Marginally Related Studies Figure 4-4 summarizes the 129 federally-sponsored programs according to category. Funding levels are included wherever such information was available.

The major energy conservation research areas include: (1) economic and policy research; (2) alternative energy sources and systems; (3) end-use research in transportation, industry and the built environment. Taken together these three main categories account for 73 per cent of the research studies funded and over 76 per cent of the funding. (The latter figure may not be an accurate reflection of the funding distribution since nine of the transportation studies have unknown funding levels.) Conservation programs most

FIGURE 4-1: FEDERAL R&D OBLIGATIONS BY FUNCTION, FY 1969, 1974 (est.) and 1975 (est.)



Source: National Science Foundation, An Analysis of Federal R&D Funding by Function, Fiscal Years 1969-75, 1974

FIGURE 4-2: FEDERAL ENERGY RESEARCH & DEVELOPMENT PROGRAM (millions of dollars)

	Progr	am Level (Obl	igations)	Percent Change	Estimated
Program Area	FY 1973	FY 1974	FY 1975	from FY 1974 to 1975	Total FY 1975-1971
1. Conservation	32.2	65.0	115.7	+ 78	700
a. End use (Residential & Commercial)	*****	15.0	15.0		
b. Improved Efficiency (Transmission)	2.9	5.0	18.8	+ 276	
c. Improved Efficiency (Conversion)	6.5	15.9	29.8	+ 100	
d. Improved Efficiency (Storage)	1.6	2.9	6.4	+ 121	
e. Automotive	7.4	14.2	23.7	+ 67	
f. Other Transportation	13.8	13.0	22.0	+ 69	
2. Oil, Gas, & Shale	18.7	19.1	41.8	+ 119	400
a. Production	.3	3.0	17.0	+ 467	-
b. Resource Assessment	4.5	5.0	13.1	+ 162	
c. Oil Shale	3.2	2.3	3.0	+ 30	
d. Related Programs	10.7	8.8	8.7	-1	
3. Coel	85.1	164.4	426.7	+ 160	2,900
a. Mining	1.7	7.5	55.0	+ 633	2,500
b. Mining Health & Safety	28.2	28.3	31.0	+ 10	
c. Direct Combustion	1.5	15.9	36.2	+ 128	
d. Liquefaction	11.0	45.5	108.5	+ 138	
e. Gasification (High BTU)*	32.5	33.0	65.3	+ 98	
f. Gasification (Low BTU)	4.6	21.3	50.7	+ 138	
g. Synthetic Fuels Pioneer Program	******	******	50.0	100	
h. Resource Assessment	1.0	. 1.2	1.9	+ 58	
i. Other (incl. Common Technology)	4.6	11.7	28.1	+ 140	
4. Environmental Control	38.4	65.5	178.5	+ 173	800
a. Near term SO	19.0	39.9	82.0	+ 174	
b. Advanced SOX		4.0	12.0	+ 200	
c. Other Fossil Fuel Pollutants		- Hill	1407	7 200	
(incl. NO _x , Particulates)	8.8	13.1	57.0	+ 335	
d. Thermal Pollution	.6	1.5	18.5	+1133	
e. Automotive Emissions	10.0	7.0	9.0	+ 29	
5. Nuclear Fission	406.5	530.5	724.7	+ 37	4.000
a. LMFBR	253.7	357.3	473.4	+ 33	-1,000
b. Other Breeders (GCFBR&MSBR)	5.6	4.0	11.0	+ 175	
c. HTGR	7.3	13.8	41.0	+ 197	
d. LWBR	29.5	29.0	21.4	-26	
e. Reactor Safety Research	38.8	48.6	61.2	+ 26	
f. Waste Management	3.6	6.2	11.5	+ 85	
g. Uranium Enrichment	50.3	57.5	66.0	+ 15	
h. Resource Assessment	2.8	3.4	10.4	+ 206	
i. Other (incl. Advanced Tech.)	14.9	10.7	28.8	+ 169	
6. Nuclear Fusion	74.8	101.1	168.6	+ 67	1,600
a. CTR	39.7	57.0	102.3	+ 79	-1,000
b. Laser**	35.1	44.1	66.3	+ 50	
7. Other	16.5	53.5	154.5	+ 189	900
a. Solar	4.0	13.8	50.0		300
b. Geothermal	4.4	10.9	44.7	+ 262	
c. Systems Studies	7.2	17.3	30.0	+ 310 + 73	
d. Misc.	.9	11.5	29.8	+ 73 + 159	
Total, Direct Energy R&D	672.2	999.1	20,0	+ 159	-

^{*}Funds for High Btu Gasification in Office of Coal Research Budget do not include Trust Fund Amounts
**Includes amounts for Laser Fusion directed toward Military Applications

Source: Presidential Energy Message, January 23, 1974, Summarized in Energy Controls: The Energy User's Guide to Meeting the Energy Crisis, Prentice Hall Inc., 1974

FIGURE 4-4: GOVERNMENT SPONSORED R&D PROGRAMS AND FUNDING RESEARCH CLASSIFICATIONS

A.	Resource Acquisition and Processing	4	\$ 960,100	
B.	Generation/Conversion/Transmission	4	954,800	(1 unknown funding)
C.	End-use (General)	3	75,000	(1 unknown funding)
	1. Transportation	17	664,900	(9 unknown funding)
	2. Industry	13	2,035,756	A STATE OF THE PARTY OF THE PAR
	3. Built Environment	26	2,519,600	(3 unknown funding)
D.	Alternative Source/Systems	14	2,038,093	(3 unknown funding)
E.	Economic/Policy Research	21	2,641,874	(3 unknown funding)
F.	Information Exchange	19	572,095	
G.	Marginally Related Studies	8	588,000	(4 unknown funding)
		129	\$13,050,218	24 unknown funding)

closely allied to new forms of usable energy also received priority attention.

In absolute terms, the spending for improving end-use programs was negligible. Even assuming that spending for transportation research approached the levels for industry and the built environment, in a two year period the amount expended would have been only slightly over 56 million, or about 1/2 per cent of total spending for energy research in fiscal 1974 alone. So neglected was end-use research that the current ERDA budget lists no spending in that category for 1974 and 1975.

With respect to energy conservation in the built environment, thirty-four research projects can be identified. Figure 4-5 shows a breakdown of these projects according to areas of investigation.

The Smithsonian Science Information Exchange, from which the preceding analysis was drawn, also listed 8 solar energy projects for the built environment. The Council's definition of conservation would include such projects, but obviously many more solar projects were undertaken during the period in question. From July of 1973 to January of 1975, fourteen federal agencies sponsored 171 solar energy projects at a cost of more than \$24 million. Results of much of this research will have a direct bearing on conservation in the built environment.

Primary emphasis has been placed on space conditioning and the application of new energy systems.

The research program undertaken thus far in the built environment is typical of the program for end-use conservation in general-limited funding and the lack of a comprehensive research strategy.

Privately Funded

No single summary of energy conservation research in industry or academia exists and a clearinghouse for such information has not been established. Some idea of the kinds of research projects focusing on energy conservation carried out recently by the private sector can be gained from a sampling of projects compiled by the Smithsonian Science

Information Exchange. Figure 4-6 summarizes these projects according to the classification scheme developed earlier. (Spending figures for these projects have not been included since funding levels for many of the projects were not provided.) As was the case with the federally-sponsored research, programs were concentrated in the area of economics and policy research and end-use applications.

FIGURE 4-6: PRIVATELY FUNDED ENERGY CONSERVATION RESEARCH PROJECTS

A. Resource Acquisition and Processing	1
B. Generation/Conversion/Transmission	3
C. End-use (General)	
1. Transportation	8
2. Industry	8
3. Built Environment	12
D. Alternative Sources/Systems	- 4
E. Economic/Policy Research	6
F. Information Exchange	1
G. Marginally Related Studies	3
	46

Privately funded research projects in the built environment are broken down by category in Figure 4-7. For the most part, private and local government efforts were concentrated in areas offering the most significant potential savings—overall building design and environmental control systems. As might be expected, projects offering practical applications for industry and government entities (such as the design of more energy efficient structures, system components, and storage capabilities) received more attention than studies dealing with life style changes or legislative questions such as building standards. Although such a small sample is probably not broadly representative of nonfederal

FIGURE 4-5: FEDERALLY-SPONSORED RESEARCH PROJECTS - BUILT ENVIRONMENT

		Overall Building Design	Building Envelope	Environmental Control Systi	Energy Storage Systems	Lighting/Illumination	Building Standards	On-Site Energy Systems	Retrofit of Buildings	Life Style Changes	Monitoring/Measurement
1.	Simulation/Validation of Environmental Control Systems			x							
2.	Conservation—Residential Space and Water Heating			×							
3.	Energy Conservation in Housing	х	x	×	x	X	×	x	×	x	
4.	Design, Analysis, Evaluation of Energy Conserving School	×					UPE I				
5.	Design of Energy Conserving Schools	X		191						-	
6.	Energy Conservation in Housing	x	х	×	x	х	x	x	x	x	
7.	Research, Design, Construction of Low Energy Utilization School	×		ME							
8.	Applied Illumination					X			- 6	1997	
9.	Service System Standards				100	10-	x		ile .		
10.	Exterior Envelope Design		х								
11.	Applied Energy Labeling								Tiel	x	
12.	Planned Ventilation	W.	x				1	7,19			
13.	Housing Retrofit					200			×	733	
14.	Planned Comfort Measures			×			x				
15.	Existing Building Energy Analysis		69				5	-		211	×
16.	New Building Energy Design	x	1				-	18		North	
17.	Retrofit of Housing								x	E 1	
18.	Optimization of Energy Utilization	x								- 1	
19.	Sealed Insulating Glass Units	1	х		12	13.	15	190			

FIGURE 45: FEDERALLY-SPONSORED RESEARCH PROJECTS — BUILT ENVIRONMENT (continued)

		Overall Building Design	Building Envelope	Environmental Control System	Energy Storage Systems	Lighting/Illumination	Building Standards	On-Site Enargy Systems	Retrofit of Buildings	Life Style Changes	Monitoring/Measurement	
20.	Energy Profile of Federal Buildings										×	
21.	Exterior Envelope Design	9/10	×	16	1		1	1	13	-11		
22.	Conservation Labeling Program	314	10	1		40			1	×		
23.	Measurement Technology		4			1	100	1			x	
24.	Heat Pumps		-	X		3	De l	100	1			
25.	Heat Pump Specification		-	x		1	THE STATE OF		17			
26.	Infrared System for Detecting, Measuring and Analyzing Heating and Cooling Losses										×	
					1				3100	-		

FIGURE 4-7: NON-FEDERAL RESEARCH PROJECTS - BUILT ENVIRONMENT

5. Energy Conservation Through Building Design X X X X X X X X X X X X X X X X X X X			Overall Building Design	Building Env spe	Environmental Control Systems	Energy Storage Systems	Lighting/Illumination	Building Standards	On-Site Energy Systems	Retrofit of Buildings	Life Style Changes	Monitoring/Measurement
3. Design Engineering of Heating and Air Conditioning Products for Mobile, Modular and Residential Housing 4. Residential Energy Use Characterization 5. Energy Conservation Through Building Design X X X X X 6. Development of Concepts for Insulating Basement Walls of Electrically Heated Home X 7. Building Energy Conservation Study 8. Optimization of Structures Based on Energy Conservation X X 9. Design of Building and Environmental Control Systems for Energy Conservation X X 10. Energy and Architectural Design X X X X X X X X X X X X 11. Conservation by Improved Building Design and Construction	1.		×		x		X			1	100	
Products for Mobile, Modular and Residential Housing 4. Residential Energy Use Characterization 5. Energy Conservation Through Building Design 6. Development of Concepts for Insulating Basement Walls of Electrically Heated Home 7. Building Energy Conservation Study 8. Optimization of Structures Based on Energy Conservation 9. Design of Building and Environmental Control Systems for Energy Conservation 10. Energy and Architectural Design 11. Conservation by Improved Building Design and Construction 12. X X X X X X X X X X X X X X X X X X X	2.	Assistance in Design of Energy Conserving Home	x	9	×	×	-13		×			
5. Energy Conservation Through Building Design X X X X X X X X X X X X X X X X X X X	3.				×							
6. Development of Concepts for Insulating Basement Walls of Electrically Heated Home 7. Building Energy Conservation Study 8. Optimization of Structures Based on Energy Conservation 9. Design of Building and Environmental Control Systems for Energy Conservation 10. Energy and Architectural Design 11. Conservation by Improved Building Design and Construction X	4.	Residential Energy Use Characterization	200	-3			. 8					x
Walls of Electrically Heated Home 7. Building Energy Conservation Study 8. Optimization of Structures Based on Energy Conservation 9. Design of Building and Environmental Control Systems for Energy Conservation 10. Energy and Architectural Design 11. Conservation by Improved Building Design and Construction X X X X X X X X X X X X X X X X X X X	5.	Energy Conservation Through Building Design	x		×	×		111	×			1
8. Optimization of Structures Based on Energy Conservation 9. Design of Building and Environmental Control Systems for Energy Conservation 10. Energy and Architectural Design 11. Conservation by Improved Building Design and Construction X X X	6,			×				V				
Conservation X X X 9. Design of Building and Environmental Control Systems for Energy Conservation X X X 10. Energy and Architectural Design X X X X X X X X X X X X X X X X X X X	7.	Building Energy Conservation Study	100	-			30		193			×
Systems for Energy Conservation X X X 10. Energy and Architectural Design X X X X X X X X X X X X X X X X X X X	8.		x	х								3
11. Conservation by Improved Building Design and Construction X	9.		x		×				8			
Construction X	10.	Energy and Architectural Design	×	×	×	×	X		х	х	x	
12. Economical Management of Energy in Buildings X	11.		x				1					
	12.	Economical Management of Energy in Buildings			×							
					18	3						
									M			

research projects, the research emphasis seemed to be on developing or adopting technical or operational initiatives to the solution of readily identifiable energy problems.

Beyond the kinds of projects highlighted in the Smithsonian survey, a number of other developments have taken place in the last two years. Several large corporations have adopted computer technology for analyzing the potential energy savings in buildings. These techniques have made possible a comparison of alternate approaches to greater energy efficiency in specific situations. During the same period, significant efforts to organize a solar energy constituency have taken place in the private sector and industry efforts to make solar technology commercially feasible have intensified.

Also not shown in the above summary are the efforts of industry associations in conjunction with energy research. The major energy industries all support rather extensive research efforts, but their programs generally are aimed at product development and increased supply. In the electric industry's research program, however, as exemplified in the work of the Electric Power Research Institute, conservation programs are estimated to account for 40 per cent of 1975 expenditures. As conservation assumes a more prominent role in national energy policy, conservation research in the private sector may grow accordingly; however, without effective advocacy for conservation, private sources may follow the federal government's lead and continue to concentrate on supply-oriented projects.

SUMMARY

Energy conservation research, both federally-sponsored and privately-initiated, remains in its infancy. Without a major shift in energy policy, research efforts in this vital field will remain inadequate. Growth in conservation research and the development of conservation demonstration projects will require significantly higher levels of funding—a development which will not take place unless a national commitment is made to capture the conservation potential.

The next section outlines present federal plans for future energy conservation research.

FEDERAL BUDGET PLANS FOR FUTURE ENERGY CONSERVATION RESEARCH

The best indications of future federal efforts in energy research and development are to be found in the recommended budget of the Energy Research and Development Administration and in the agency's National Plan for Energy Research, Development and Demonstration.

Figure 4-8 shows the proposed program and financing data for ERDA in fiscal 1976. While the proposed budget is in excess of \$3.7 billion, over \$200 million will go to cover the cost of program support, and over \$1 billion (in the categories of weapons, laser fusion, nuclear materials security, and naval reactor development) is earmarked for

national security. This leaves about \$2.5 billion for research in support of our national energy policies.

Spending for nuclear energy has again received the highest priority, commanding more than 60% of ERDA's total budget. Thus, nuclear energy continues to be relied upon as the dominant long-range energy source of the future, though there are substantial increases in funding for alternate and other relatively undeveloped sources of energy.

The recommendations for solar energy expenditures are significant for energy conservation in the built environment. In percentage terms, an increase of 551% in solar energy spending seems to signal a more prominent role, but that is not necessarily the case. This large percentage will still provide only about 1½% of the total ERDA budget. The amount is less than 55% of the accelerated budget recommended by a National Science Foundation panel of experts (the Eggers Panel) in a report submitted to Dr. Dixy Lee Ray in 1973. The panel's recommendations are summarized in Figure 4-9.

Spending for exploring ways to use energy more efficiently amounts to less than 1% of the total budget. End-use conservation programs, which are of particular importance for conservation in the built environment, will receive only \$3 million out of a total budget of over \$3% billion.

The objective of end-use conservation research, as described in the budget appendix, is to develop "new technologies for reducing energy utilization" in residential and commercial buildings. In addition to recommending only \$3 million for the program, the only activities described under the heading of end-use conservation are research on energy efficient appliances and the development of techniques for determining the potential returns of end-use conservation.

Priorities reflected in ERDA's budget have changed somewhat (at least rhetorically) since the new agency has begun its operations. Under its enabling legislation, ERDA was directed to develop a comprehensive national energy plan; Volume I of the proposed energy agenda, A National Plan for Energy Research, Development and Demonstration: Creating Energy Choices for the Future, sketches a more balanced energy program than the budget under which ERDA will be operating for the current fiscal year. Both energy conservation and solar energy are considered integral parts of national energy policy according to the scenarios developed in the ERDA report. The true test of the strength of that conviction, however, will come in the yet to be received funding recommendations which will result from efforts to implement the comprehensive energy plan.

Recommendations for federal initiatives in end-use conservation as outlined in the ERDA national plan are sketched below in Figure 4-10. According to ERDA's estimates, implementation of the recommended programs would yield savings of between 2.5 and 6 Quads annually in 1985 and as much as 4.5 to 9.5 Quads annually in 2000 within each of the end-use categories.

FIGURE 4-8: PROGRAM AND FINANCING (IN THOUSANDS OF DOLLARS)

dentification code 19-00-0100-0-1-999	actual 1974	1975 est.	1976 est.
rogram by activities:			
Direct program:			
Fossil energy development:			
(a) Coal	62,613	174 100	270 472
(b) Petroleum and natural gas	7,877	174,199	279,473
(c) Oil shale	2.780	17,267 3,454	23,647 8,147
Solar, geothermal, and advanced energy systems development:	2,700	3,404	0,147
(a) Solar energy development	3,937	8,770	57,100
(b) Geothermal energy development	6,231	13,800	28,370
(c) Advanced energy systems research	4,160	12,284	23,173
(d) Physical research	252,825	281,600	312,500
3. Conservation research and development:	,	201,000	312,000
(a) Electric power transmission	1,531	6,372	11,830
(b) Advanced automotive power systems	1,500	4,490	8,240
(c) Energy storage systems	1,689	5,800	9,100
(d) End-use energy conservation research and development	********		
4. Nuclear energy development:			
(a) Fusion power research and development	52.968	85,030	120,000
(b) Fission power reactor development	286,301	384,088	443,675
(c) Naval reactor development	154,122	167,000	186,200
(d) Space nuclear systems	26,237	26,600	30,900
(e) Nuclear materials	511,374	646,080	828,940
(f) Advanced isotope separation technology	3,272	11,700	24,200
5. National security:			in the same
(a) Weapons	785,874	819,997	873,515
(b) Laser fusion	36,853	41,400	54,000
(c) Nuclear materials security	4,365	5,863	10,945
6. Environmental and safety research:			TALIED I
(a) Biomedical and environmental research	106,260	132,215	156,515
(b) Waste management	16,606	29,570	36,000
(c) Operational safety	2,124	3,210	5,160
7. Program support	150,434	175,898	200,018
8. Cost of work for others	17,104	11,690	12,660
9. Adjustments to prior year costs	7,790		*******
Total direct program costs	2,506,827	3,068,377	3,747,308
	-		

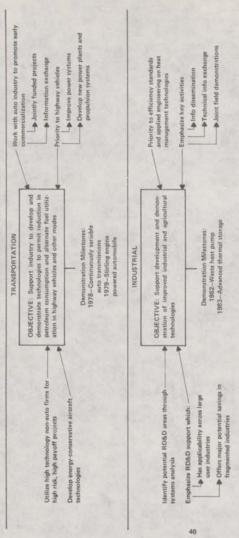
Source: The Budget of the United States, Fiscal Year 1976, Appendix

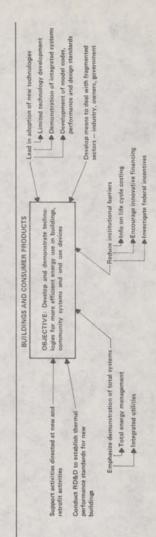
FIGURE 4-9: SOLAR ENERGY PROGRAM RESOURCES (Millions of \$)

35.7 20.0 20.0 17.3 17.3 19.2 4.5	10.3 11.0	188.9 237.2
17.8 17.8 17.8 16.8 16.8 16.8 16.8 17.1 17.8 18.5 18.5 18.5 18.5 18.5 18.5 18.5 18	10.3	106.4

Source: Solar and Other Energy Sources: Report of Subpanel IX to the Chairman of the U. S. Atomic Energy Commission (Wash. 1281.9), 1973

FIGURE 4-10: FEDERAL INITIATIVES-END-USE OBJECTIVES





The ERDA plan recognizes that where the capability exists for the private sector to develop effective conservation technologies and to introduce them on a broad scale (e.g., automobiles and large industrial energy users), the federal role ought to be supportive and not necessarily predominant. In the buildings and consumer products sector, where ERDA expects institutional and economic difficulties, federal activity apparently will be more pervasive. A facilitative role on the part of the federal government probably is a must in this sector because of traditional business arrangements and financing problems, but if private initiative is not encouraged, only a limited amount of conservation may

With respect to conservation in buildings and consumer products, ERDA's program plan sets out the following objectives:

Near-Term (-1985): To permit a decrease in unit

energy consumption in existing buildings and community systems of 20 per cent and in new buildings and community systems of 30 per cent.

Mid-Term (-2000): To permit a decrease in the unit consumption of energy in existing buildings and community systems by 30 per cent, and in new buildings, community systems, and consumer products by 50 per cent.

To develop and demonstrate conservation technology and institutional changes which will aid the widespread utilization of solar energy for heating and cooling buildings, thereby reducing the consumption of nonrenewable resources by 12 per cent by the year 2000.

To achieve energy conservation in buildings, ERDA contemplates developing performance standards for all buildings, an approach which, if adopted, will require considerable research to provide an up-to-date data base for drawing up workable standards. ERDA anticipates the need for research primarily in the areas of equipment for space conditioning, lighting, computerized controls, heat recovery and storage, and building components and envelopes. Environmental problems should not be of much concern, according to the program plan, since increased efficiency will tend to reduce the impact of overall energy consumption.

Major obstacles to energy conservation in buildings, as ERDA foresees them, should be institutional. They will include:

- (1) a fragmented and conservative building industry;
- (2) traditional financing methods based on first costs rather than life cycle costs;
- (3) possible restrictions on innovative technologies because of building codes, property taxes, construction practices, etc.

Thus not only technological and hardware research but also policy research studies will be required.

With the supply-dominated mentality firmly institutionalized, the expansion of federal support for energy conservation or alternate energy systems will be difficult to obtain. Much of the available money for energy research and development is already "committed" in any budget. When expressed as a percentage of increase, spending for relatively new research areas will sound impressive, but in absolute terms such spending will remain relatively insignificant for years unless there is a basic shift in our operational strategy.

Although energy conservation is supposed to be a major component of the nation's strategy for dealing with our energy problems, the proposed funding levels for conservation research and development indicate a far different set of real priorities. The budget for fiscal 1976, like those of the past several years, relegates conservation research to a relatively meaningless position. If this imbalance continues for another two years, it is likely to cause the nation to miss most of the conservation potential for at least two or three

The next chapter discusses a recommended alternate national program.

CHAPTER V: A RECOMMENDED NATIONAL PROGRAM OF ENERGY CONSERVATION RESEARCH FOR THE BUILT ENVIRONMENT

OVERVIEW

Preceding chapters make it apparent that the nation's present and planned research activities in energy conservation are inadequately funded, too narrowly oriented, and lacking in long-term basic research. While these generalizations apply to all the energy sectors, this chapter will deal only with a suggested national program for energy conservation research in the built environment.

As pointed out in Chapter I, the "built environment" includes the design, construction, and operation of buildings; the land use concepts and practices which determine spatial relationships of buildings; and the various functions which are conducted within and among them. Thus, the built environment may be thought of from the standpoint of a variety of "entities".

individual buildings of all kinds;

 buildings in close proximity with energy integration potential, e.g., in residential clusters, commercial facilities, and various industrial operations;

• buildings within given areas: like neighborhoods, communities, inter-urban areas, and metropolitan areas. In approaching the development of research programs, several other dimensions must also be taken into account. For example, Chapter IV shows that present research activities have primarily been structured around functional component systems such as heating and cooling, lighting, exterior walls, and on-site solar generating systems. Each of these component systems of individual buildings is looked at in terms of the function the building serves.

The relationships to external energy supply systems (electricity, natural gas, fuel oil, and coal) are also important parts of the overall framework for understanding the total or "net" energy requirements of the built environment. This "external" category also includes the energy units "imported" in the materials and techniques used for construction.

In addition, a balanced research program would include different categories such as basic research, exploratory development, applied research, demonstration projects, and the infusion of knowledge and technology into general usage.

Finally, research approaches are fundamentally affected by whether one is thinking of retrofitting or modifying existing entities within the built environment or of capturing the opportunities associated with the creation of new entitles in such efforts as urban redevelopment, community growth, new towns, or emerging urban centers.

DEFINING THE DESIRED SYSTEM CHARACTERISTICS OR STRATEGIC ATTRIBUTES

The basic strategic attributes of the nation's energy systems were outlined in Chapter II. Starting with these general concepts, the desired system for energy use in the built environment can be defined as one which, to the maximum degree feasible, reflects the following attributes:

The source of the energy is more important than
the amount which is consumed. Thus, reliance upon
energy derived from nonrenewable resources is to be
minimized. If given a choice between reducing quantities
consumed but obtained from nonrenewable resources, or
consuming more in gross BTU's but "importing" less
from nonrenewable resources, the latter choice is
preferable.

• Wherever feasible and economically justified, energy should be derived from natural recovery and recycling processes within each building, thus implementing a concept of maximum decentralization with minimum import requirements. This strategy begins with each building and moves outward to groups of buildings, communities, and regions.

 Waste resulting from inefficient technical systems will be reduced to a minimum.

 There will be connections to reliable centralized systems to provide reserve or residual energy needs.

 Prohibitive pricing will not be required or used as a means of rationing limited supplies.

It is clear from the above that energy conservation is more appropriately termed energy efficiency. The objective is not just to minimize consumption, but also to structure the consumption in terms of what it is for (productive use or waste), and to structure the supply in terms of how it is derived (renewable vs. nonrenewable resources, on-site supply vs. imported supply).

For the remainder of this chapter, energy conservation will be considered as synonymous with energy efficiency, which is defined as:

- maximum feasible reduction of demand requirements related to waste;
- maximum feasible utilization of on-site energy derived from combinations of natural processes and recycling;
- employment of the most energy efficient centralized reserve system, taking into account the total system implications.

SETTING THE ACHIEVEMENT GOALS TO BE SUPPORTED BY RESEARCH

The proposed research program supports action-oriented goals. Therefore, it is helpful to specify several achievements which should be sought and which the research should be tailored to support:

 By 1990, 90% or more of the individual buildings should be energy efficient, i.e., traditional supply requirements will have been reduced by an average of 30% in structures existing at the end of 1976 and at least 60% in structures built from 1977 forward.

- After additional study, the attributes of and necessary developments for energy efficient neighborhoods, communities, and metropolitan areas should be defined. This conceptual process should be accompanied by the identification of applicable supporting technologies on hand, under development, or needed to be developed.
- Urban expansion, redevelopment, and new urban growth centers started after the above definition of such expanded energy efficient building relationships, should be constructed so as to maximize overall community energy efficiency; equivalent consumption of traditional energy supplies in such communities (including factors such as transportation) should be reduced by a specified target over and above reductions allocated to individual buildings.
- Neighborhood, community, and metropolitan areas already in place by the completion of the preceding steps should be evaluated against a series of "retrofit" strategies which will achieve reductions of a specified target over and above those allocated to individual energy efficient buildings. These retrofits should be achieved on a priority basis in communities which collectively account for at least 60% of national energy consumption for the built environment. The retrofits should be put into place at a rate which will achieve the objective by the turn of the century.

These goals are optimistic and are not likely to be realized. However, for purposes of establishing research priorities, it is wise to set ambitious goals. Recognizing the lead times involved, it is necessary to have a research and development program which will remove as soon as possible the technological and state-of-the-art barriers to fulfillment of these objectives.

COMPONENTS OF A BALANCED NATIONAL PROGRAM A balanced research program must span activities related

to each of the dimensions discussed at the beginning of this chapter:

- (1) "Entities" within the built environmen
 - (a) individual buildings
 - (b) buildings in close proximity
 - (c) buildings within given areas at four levels
 - 1. neighborhood
 - 2. community
 - inter-urban area
 metropolitan area
- (2) Overall building design
- (3) Component systems within buildings
 - (a) building envelope
 - (b) HVAC

- (c) lighting/illumination
- (d) energy storage systems
- (e) on-site energy systems
- (4) Relationships to external energy supply systems
 - (a) electricity
 - (b) fuels for conversion on-site
 - 1. natural gas
 - 2. fuel oil 3. coal
 - 4. other
- (5) Categories of research by type
 - (a) basic research
 - (b) descriptive research
 - (c) exploratory development
 - (d) applied research
 - (e) demonstration projects
 - (f) infusion into use
 - institutional mechanisms
 conducive policies and incentives
 - a. economic
 - b. social/political
- (6) Physical condition of the "entity" involved
 (a) Retrofit, redesign, or modification of existing buildings, neighborhoods, etc.
- (b) New buildings, neighborhoods, towns, etc. When viewed from this framework, the imbalance of the existing research activities comes into even sharper focus. Present programs (almost totally) concentrate heavily upon:
 - a series of individual demonstration projects for various component systems within a variety of buildings (residences, offices, schools, etc.). These are designed to illustrate the present state of the art.
 - a limited amount of work on energy properties of each of the building subsystems as they relate to setting energy standards for buildings.
- a limited amount of descriptive research, largely related to economic input/output relationships and other economic aspects of applying energy conservation technologies.

All of these programs are needed and can be justified in the sense of giving priority to more extensive application of present technical capabilities. In fact, however, even with this concentration, present levels of funding cannot be expected to produce the desired results. Beyond this, the deficiencies of an unbalanced, noncomprehensive program will begin to be felt accurately within the next several years.

These deficiencies cannot be compensated for quickly by a rapid infusion of funds in a crisis reaction. Now is the time to make these investments. They are more than justifiable in terms of normal economic investment criteria. Even more importantly, such investments are politically and socially essential if our quality of life is to be sustained. All our citizens will benefit in both economic and qualitative ways.

In outlining the recommended national research program, we have decided to present the structure in terms of types of research. Though the preceding outline lists the categories in sequence from basic research through infusion. the following discussion will begin with descriptive data and proceed through infusion (the end of the spectrum closest to application) back toward basic research. Some activities will actually overlap in several categories. They will be discussed under their prime headings, however.

The recommended program might be viewed as a five-year program. The activities should begin as soon as possible and should be sustained for at least that period of time. Annual levels of financing are given for some programs, but not for others. However, Figure 5-1 summarizes the recommendations and lists the overall recommended budget levels by research category. Needless to say, the composition and priorities of the program are extremely dynamic and should be reviewed and updated at least annually.

SUBSTANTIAL AMOUNTS OF ADDITIONAL BASELINE DATA ARE NEEDED (DESCRIPTIVE RESEARCH)

Though a number of data-developing and model-building activities have been launched, they are only a modest start The following paragraphs outline the Council's key recommendations regarding data and model development activities. These activities are discussed first because they will develop many ideas related to each of the other research categories.

UNDERSTANDING THE ENERGY CONTENT PROPERTIES OF BASIC BUILDING MATERIALS

There are many materials which can be used in an almost unlimited array of combinations in construction of our built environment. While much is known about the strength, safety, and various other properties of materials, in some cases there is insufficient, inappropriately organized knowledge of their energy properties. Each material has at least nine separate dimensions of energy properties

- (1) The amount of energy required to produce it.
- (2) The amount of energy required to deliver it to the project.
- (3) The amount of energy required to put it in
- (4) The amount of energy required to maintain it (physically).
 - (5) The amount of energy required to remove it.
- (6) The amount of energy required to dispose of it (after removal).
- (7) The amount of energy contributed as salvage or used as a source for other products (as opposed to virgin materials).
- (8) The energy flows which it manifests when in use by itself.
- (9) The energy flows which it manifests when used in various combinations with other materials.

A detailed catalog of this type of data is an important foundation to establishing the scientific basis for designing optimal energy efficiency into the built environment. Recommendation

Such data can probably be developed most expeditiously through the existing channels for determining the physical properties of materials. The program should be augmented with research into the development of new materials which embody more desirable energy properties. This program should be carried out by a partnership of industry, government, academia, and non-profit institutions. The first step might be a three day workshop for interested participants. This procedure would be used to produce a proposed structure and plan. The proposal would then be circulated for comment, modified, and reevaluated by the original workshop participants. A final plan for this program on materials and energy properties should be submitted as quickly as feasible. In participation of this plan, the federal government should set aside a fund of up to \$15 million. Major industrial corporations should also be asked to budget for performance and support of this program. Private funds equal to perhaps one-tenth of one per cent of the materials used in one year's construction would be appropriate.

This program should be administered through a special inter-agency governmental body in conjunction with a private sector counterpart.

UNDERSTANDING THE NET ENERGY CONSUMPTION WITHIN NATIONAL ECONOMIES

As noted on pages 18 and 22, unfavorable comparisons have been made between U. S. energy consumption and that of other national economies. Available data seem to support the argument that America's "consumption orientation" has produced energy wastefulness, but additional research is necessary to produce more valid cross-national energy usage comparisons.

Recommendation

Accordingly, the Council recommends that a program be initiated to develop concepts of net energy imported and exported by the U.S. economy in the form of materials, goods, and services. This will yield a "net energy for U.S. consumption" measure which will provide valuable information for the world community, as well as insights for more effective energy efficiency within our own economy.

These data should be developed from an analysis of materials and the flow of materials through the U.S. industrial and economic system. The data can be refined over time to develop a national materials energy flow model by 1980.

UNDERSTANDING THE ENERGY FLOWS FOR BUILD-(A NATIONAL MODEL/EXPERIMENTAL/ DEMONSTRATION PROGRAM)

Substantial data banks are being generated with respect to the energy dynamics within component systems of buildings. There are also efforts underway to develop

FIGURE 5-1: RECOMMENDED RESEARCH PROGRAM AND FEDERAL FUNDING LEVELS FOR ENERGY CONSERVATION RESEARCH IN THE BUILT ENVIRONMENT

		Recom	mended Fed	deral Fundin	g Levels	
			YE	AR		
	1	_2_	_3_	4	_ 5	
Descriptive Research	25M	20M	15M	10M	10M	
Energy properties of materials						
2. Energy flow model into, within, and from the						
U.S. economy 3. National profile/model of energy flows in						
buildings						
4. National profile/model of energy flows for						
various homogeneous groups of buildings						
5. National profile/model of energy flows for neighborhoods						
6. National profile/model of energy flows for						
communities and metropolitan areas						
7. Inventory and analysis of recycling potentials between various industrial and other energy						
flow processes						
Infusion	10M	10M	10M	10M	10M	
1. A series of barrier analyses oriented to moving						
technical states of the art into use						
2. An integrated collection of barrier analyses						
and a national innovational plan 3. A set of national education and training						
programs for professionals and tradesmen						
4. Clearinghouse of successful energy conserva-						
tion applications should be established						
Demonstration Projects (Subsidy of Extraordinary	50M	50M	50M	50M	50M	
Risks and Costs) 1. Nationally balanced set of demonstration						
projects						
2. Special program for developing, testing, and						
demonstrating a concept for "Integrated						
Energy Utilities" for energy efficient buildings						
Applied Research	50M	50M	50M	50M	50M	
1. Developing "next generation" technical						
capabilities						
Exploratory Research	10M	15M	15M	15M	15M	
Developing second and third generation techni- cal capabilities						
Basic Research	10M	15M	15M	15M	15M	
1. Developing underlying theories and advancing						
the state of fundamental knowledge						
Totals	\$155M	\$160M	\$155M	\$150M	\$150M	(\$770N

minimum energy standards for buildings by use, location, and type of construction. However, there is not yet a coordinated effort to develop the equivalent of a national model for the energy flow dynamics of the U.S. building inventory.

This capability can be developed in terms of building profiles which will represent a range of building situations within the United States. At this point it is impossible to say how many such "cases" would be required to give a valid national sample, but the number should be in the thousands rather than the tens of thousands.

This national building profile can serve as a basis for developing a network of instrumented buildings used to provide actual data on energy flows in building operations. From this program, a reliable national model of energy consumption within buildings could be developed. This in turn can be used for a wide variety of technical and policy developments. The case study buildings could also be used for design of various forms of energy efficiency retrofit packages.

Recommendation

A national sample profile of the nation's building inventory should be developed, and specific buildings within the sample identified and instrumented. These buildings will be used to develop a national building energy model and also to demonstrate alternative retrofit concepts. The focus of the effort would be to achieve energy efficiency at the level of the building, rather than at the level of individualized systems within the building. Analysis of the information gathered in instrumented buildings should also be useful in providing baselines for determining energy performance requirements for buildings (popularly known as annual energy budgets) which would specify the maximum quantities of energy which a general type of building in a given locale should be allowed to consume. (Note: It should be emphasized again that the objective of energy efficiency may not be minimum consumption, but rather minimum net import of energy derived from nonrenewable resources.) UNDERSTANDING ENERGY FLOWS AND ENERGY

EFFICIENCY FOR PROXIMATE BUILDINGS Reco

After further conceptual work, the procedures suggested above for individual buildings should be developed and executed for proximate buildings such as several apartment buildings within a complex, shopping centers or malls, etc. UNDERSTANDING ENERGY FLOWS AND ENERGY EFFICIENCY FOR NEIGHBORHOODS

Recommendation

Again, following the necessary conceptual formulations, an inventory of energy consumption at the neighborhood level should be pursued in approximately the same manner as described above. However, at this point implications of integrating land use alternatives with energy efficient buildings and building complexes become more crucial.

UNDERSTANDING ENERGY FLOWS AND ENERGY EFFICIENCY FOR COMMUNITIES AND FOR METRO-POLITAN AREAS

The supply and flow of energy within entire communities and metropolitan areas can be developed through the kinds of techniques mentioned above. However, at this point there would be a requirement to integrate a variety of sophisticated technical alternatives. As only one example, if the material and energy flows of each industrial process within the U.S. economy were known, it would be possible to devise concepts of industrial location which would allow optimal recycling and overall energy efficiency. Of course, many other factors would go into deciding upon industrial sites, but these emerging economies of energy efficiency will become an increasingly important criterion for plant location. A potential result is the formation of energy efficient industrial parks, structured in a manner which brings industries adjacent to one another in order to integrate industrial processes across industry and company lines. Recommendation

In addition to the data compilation and model-building procedures (which would follow the same pattern as the above approaches), the Council recommends that a program be launched to investigate the potentials for better utilization of energy presently wasted among various industrial processes. For example, it might be possible to explore using the heat generated by some processes, which must now be treated as thermal pollution, as a salable by-product. Such activities are emerging, but we do not find an aggressive, comprehensive, and integrated program designed to fill this basic data need, Individualized demonstration projects are useful but wholly inadequate to capture the dramatic potentials which are offered by this approach.

MORE ADEQUATE INFUSION STRATEGIES AND SUPPORTING PROGRAMS ARE NEEDED (DISSEMINA-TION)

The present research strategy of the federal government largely assumes that demonstration projects will result in the technical capabilities being "picked up" by the mainstream of the economy and used. Yet, experience in case after case has shown that this assumption is not always reliable. Many structural, institutional, and attitudinal changes will be necessary if the nation is to achieve the goals set forth in the beginning of this chapter. Extensive educational and training efforts will also be required if the nation's professionals and tradesmen are to develop an effective delivery capacity.

Accordingly, present research activities should be substantially broadened to include alternative economic, institutional, and other policy initiatives which will be necessary if state-of-the-art technical capabilities are to be realized.

This research might be structured using a concept called "barrier analysis." Barrier analysis includes a series of inter-related inter-disciplinary analyses which essentially "fill in" the type of matrix shown in Figure 5-2,

The barrier analysis technique may be conceived of as a generalized, variable-parameter model of a hypothetical environment. In this model, the different components of the environment can be varied to determine the probable success or failure of the proposed action or innovation. Barrier analysis has been successfully applied to the technological innovation process, and, although energy conservation is not a purely innovative process, many of the same barriers will be encountered in making energy conservation ideas operational. As applied to energy conservation opportunities, the hypothetical environment of barrier analysis will include both research/development and technology transfer components.

Reading from left to right on the matrix (categories one through four), there will be barriers associated with expanding the research base. Gaps still exist in basic knowledge about energy conservation, in applied engineering, and in the descriptive capacity of the present system. Until these gaps are narrowed, the implementation of certain conservation innovations will not be possible. For example, innovations or conservation techniques which are barely advanced beyond the theoretical stage obviously will encounter a broader, and at the same time more intense, range of barriers than candidate opportunities which have progressed beyond the research and development stage.

The technology transfer barriers (categories five through eight) can be summarized as follows:

Inventory barriers (supply-related institutional). This category deals with the aggregation of an effective delivery system that can provide the technology in the appropriate form.

Integration barriers (delivery system-related institutional). These barriers deal with the "receptor" of the technology. This is the output delivery system that employs the technology in rendering products and services.

Economic barriers (supportability). This category relates to the economic aspects of employing the technology.

Social/Legal/Political barriers (desirability). This category includes a diverse array of value and institutional issues. In general, these barriers can be the most critical: They account for many unexpected innovational failures because of the fallacious assumption that if the other three barrier categories are surmounted, these barriers will dissolve.

It also should be recognized that there are often very positive, even compelling, factors militating in favor of the adoption of a technique or innovation. These positive factors must be taken into account in making a final judgment as to the opportunity or probability of success in any situation. For example, a societal need for a new innovation may help to overcome quickly what otherwise might be a difficult set of obstacles. Thus, certain conservation opportunities might be more readily absorbed because of their potential ability to meet critical needs.

Data developed under the descriptive research programs will provide valuable inputs into this barrier analysis. Once the barriers are well understood, appropriate policy and institutional initiatives can be developed. Many individual projects will be required to compile a comprehensive encyclopedia or reference volume of barrier analyses, but such an integrated volume should be designed and assembled as work progresses.

Recommendation

The federal government should organize a special program designed to support a range of discrete projects which will produce a comprehensive set of "barrier analyses." These resulting sets should be integrated into an overall catalog by the end of 1977. Such analyses should provide detailed assessments of strategies to achieve each of the objectives set forth at the beginning of this chapter.

Achievement of conservation objectives should be regarded as a major, complex, national innovation problem. A comprehensive innovational strategy should be developed to produce a plan for proceeding and a framework within which to evaluate progress.

Once formulated and assembled, this "barrier analysis/ innovational plan" should be updated regularly to provide smooth and efficient infusion of future advances in technical states of the art.

Recommendation

The information collected above (particularly the inventory of technical capabilities) can provide a framework to develop various curricula for a series of national educational/orientation programs. These programs should be application-oriented, related to demonstration projects (discussed later), and accessible to practicing professionals and tradesmen, financial policy makers, and other actors who collectively comprise delivery/market systems.

Recommendation

A clearinghouse of case studies of energy conservation/ efficiency activities should be established to provide effective interchange and dissemination of information about both successes and failures. This information should be broadly disseminated through professional and trade journals, mass media, and a variety of other channels. Care must be taken to protect proprietary interests when appropriate.

DEMONSTRATION PROJECTS

As noted in chapter IV, most of the present research activity falls into the category of "scattered" demonstration projects oriented to particular types of component energy systems within buildings serving a variety of purposes. Through grossly inadequate as the nation's main research program, these demonstrations offer solid, near-term opportunities and should be substantially expanded.

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FIGURE 5-2: BARRIER ANALYSIS MATRIX

	BARRIERS	Gaps in Basic Knowledge	N Gape in Applied Engineering	Gaps in Descriptive Capacity	Gape in Assembly of State of the Art into Supply System	Gr Inventory	Integration	Economic	5ocial/Political/Legal
Specifi Technolo Needs (Capabil	ied ogical and ities								
+									

Demonstration projects should be looked at as "display windows" field testing under ordinary conditions those technical capabilities flowing from applied research programs. An adequate structure of demonstration projects would display the entire range of states-of-the-art and technical capabilities.

Present demonstration activities do not fulfill this requirement. The "case study" profiles developed under descriptive research will provide excellent demonstration potentials which can be economically integrated and scientifically controlled for applied research, experimentation, and demonstration.

Obviously, demonstration activities are an important dimension of private industry efforts. However, government/ private partnership is to be encouraged. Recommendation

The inventory of technical capabilities developed in conjunction with the "barrier analyses" should be used in connection with the national profiles to structure an effective, comprehensive set of demonstration projects. Each of those projects, once defined, should be evaluated to determine both the most appropriate institutional responsibilities and effective means of execution.

A SPECIAL SET OF NATIONAL DEMONSTRATIONS FOR NEW INSTITUTIONAL CONCEPTS

As mentioned in Chapter III, a strategic program for A Nation of Energy Efficient Buildings by 1990 has been outlined. Reports by the American Institute of Architects have described a new form of public utility called a "Building Energy Utility." A forthcoming report will deal with this idea in more detail and will suggest a plan for national demonstration projects to refine and test the concept. Recommendation

We recommend that a special inter-agency group directly responsible to the President be assembled to launch these demonstration projects as a major part of the nation's Bicentennial Era. The Advisory Council will have more specific recommendations to make in this regard during the coming year.

APPLIED RESEARCH FOR DEVELOPING ALTERNATIVE "TECHNICAL PACKAGES" FOR ACHIEVING VARIOUS LEVELS OF ENERGY EFFI-CIENCY

The demonstrations closely relate to and flow from previous applied research. Each of the modeling programs and barrier analyses described above should be operated in conjunction with technical assessment analyses to define the various technical alternatives which exist or which will exist on the basis of current research activities. This procedure will help to identify the gaps in current technological development programs by starting from a comprehensive picture of the desired end system or final product and relating this to basic knowledge.

The results of these technical analyses should be used to establish applied research and development programs within the present state of knowledge in order to close the technical gaps, to further improve the technological base currently available, and to develop imaginative demonstration projects. Attention should be given to expanding the technical capabilities beyond current technology. As previously noted, present research activities of this type are very limited. Recommendation

As the preceding programs and models are being developed, they should be used to formulate technical goals and objectives, which in turn will become specifications for applied research and development associated with "next generation" technologies. We emphasize that the concepts should emerge from examining the various "entities" of the built environment, rather than from thinking in terms of the component energy systems within buildings. A near term set of technical requirements which will stimulate the next generation of energy efficiency technologies within the built environment should be developed from this procedure. These technologies will not only include building entities, but will also extend to groupings of buildings.

These technical specifications can then be used as a basisfor developing a priority ranking of specific applied research projects and programs.

EXPLORATORY DEVELOPMENT

Beyond applied research oriented to the next generation of technical capabilities, there is goal-oriented exploratory development. The principal distinction is one of timing. Exploratory development might be characterized as a "mining operation" drawing imaginatively from all forms of basic knowledge to create second or third generations of technical capabilities. Present research of this kind related to energy conservation is virtually non-existent. This range of developments will be needed for applied research, demonstration, and infusion beyond, ay, 1985 or 1990.

Specifically, qualitative leaps in the efficiency of solar systems will be needed. Other concepts for acquiring renewable on-site generating capability and for greatly enhancing the potential of recycling are also necessary. Perhaps entirely new concepts in building materials will be feasible.

Recommendation

There should be a program definition phase conducted over the next several months to define an initial program for exploratory development. Since this work is so closely connected with basic research, the Council recommends that this become an integrated portion of the approach suggested in the next section for basic research. However, exploratory development is more goal-oriented than basic research and should have its own identifiable program.

BASIC RESEARCH

One startling feature of current conservation research is the absence of basic scientific research. This may be due in part to the fact that energy conservation is not considered a distinct scientific discipline. Its theoretical structure must be derived from > variety of the physical, life, and social sciences. However, imaginative projects which can produce such equivalent "leaps" as those in the atomic sciences have not been considered. While the "payoff" from such research is not definable, the history of scientific and technical development has adequately documented the need for nourishing such basic developments in the state of knowledge.

Recommendation

A series of high priority, inter-disciplinary working sessions should be convened within the scientific community and assigned the task of:

(1) Developing and/or bringing together a theoretical structure for energy conservation/efficiency.

(2) Identifying a series of fundamental basic research (and exploratory research) activities which are aimed at "filling in the theoretical structure."

(3) Developing specific proposals for the types of projects, team composition, funding levels, and institutional settings which are most appropriate for proceeding with basic research applicable to energy conservation.

These workshops should be held under a variety of auspices. Perhaps the National Academy of Sciences and the National Academy of Engineering would lead one prong of the effort. Another initiative should be regionalized meetings open to a broad spectrum of scientists and held under the auspices of a "scientifically neutral" group such as this Advisory Council or some other suitable non-scientific institution. A leading business or industrial organization could conduct a third part of this effort.

These activities should be conducted in parallel. The results of each series of workshops should be made available to interested individuals and institutions. Following an integrative and analytical process, the information gathered in such workshops could form the basis of a proposed agenda for basic research (and exploratory development).

The relative costs of this program definition work are

small. However, since the results probably will be forthcoming at the beginning of or during FY 1977, the federal government should budget an estimated allocation of \$10 million in the FY 1977 budget. Those funds would be available for immediate release upon final decisions as to the initial projects or institutional initiatives to be launched. This will preclude a year or two year lag which would otherwise be required to inject the program into the budget.

Private funds could be added to this basic core of federal support as the programs evolved.

SUMMARY

We believe this report dramatically shows that the nation's energy research priorities are seriously unbalanced and that research for energy conservation should be substantially increased and extended into a full-scale, comprehensive program.

The foregoing recommendations outline how to begin this process. Many modifications will undoubtedly be required, and annual reviews will be essential to evaluate both our progress and new needs.

To some, the financial recommendations will appear extraordinarily high. However, if the cost is compared to the potential benefits which will accrue to each citizen and the nation, these investments will seem more than justified. In fact, economic investment criteria alone would lead us to make many of these investments in preference to the more uncertain and much larger investments being made for nuclear and fossil fuel supplies.

The program should be a national program, and thus this report has concentrated heavily upon the federal role and budget. This is due largely to our belief that federal leadership and financing are essential to a well-balanced, coordinated, and adequately integrated national program.

Nevertheless, new dimensions of governmental/private sector partnerships will be needed, but there is a great deal of experience and many flexible arrangements from which to draw. The Council has deemed it more important in this report to concentrate upon the concept of what a balanced national program should include.

The Council urges the nation to regard these proposals as urgent business and to act now on beginning their execution.

APPENDIX

Estimates of energy savings averaging 30% in retrofit situations and 60% in new buildings were used in Chapter III as reasonable assessments of achievable conservation levels. These figures represent reductions of demand for nonrenewable resources used in or through centralized supply systems in the built environment. Although inadequately supported by empirical evidence, the estimates are well within the range of projected energy savings formulated by individuals and organizations working with energy usage in the built environment.

To cite several examples:

- ERDA's mid-term objectives in relation to conservation in buildings and consumer products are to decrease unit consumption in existing buildings and community systems by 30%, and in new buildings by 50%.
- FEA, in a review of the building sector, estimates savings of 20% to 50% of the energy used in present buildings depending upon the type of construction; in new buildings, the estimated savings are 50% of the projected increase in overall energy used.
- L. S. Windheim in Energy Conservation in Buildings for the Ford Foundation Energy Policy Project

claims possible savings of 80% in the new buildings (including 15% for climate) and 40% for existing buildings. Both figures include savings derived from improved operation and maintenance practices.

 GSA's Energy Conservation Design Guidelines for Office Buildings shows estimates of 60% savings for better construction and internal design systems; estimates are based upon studies by Dubin-Mindell-Bloome Associates and Isaaks and Isaaks, Architects.

• Energy Conservation in Public and Commercial Buildings (RAND P-5093), dealing with primary energy for new air-conditioned high-rises, claims possible reductions of 25% in existing structures and 45% in new buildings are feasible by 1985; other figures in the study estimates that new savings would be 60% below present practice.

The examples above generally do not take into account extensive use of on-site systems to reduce the demand on nonrenewable fuel resources. Energy conservation, as defined in this report, would include the introduction of such on-site systems wherever feasible. These systems alone may provide 25% to 80% or more of energy needs. Considering this additional dimension, the energy savings estimated in this report can be regarded as conservative.

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Mr. Daly. My name is Leo A. Daly; I am an architect.

Mr. Ryan. Before you begin, Mr. Daly, I want to welcome you here and to note in passing, for the record, that you and I have never met. We do, however, share a common interest. I am a graduate of Creighton University, and I believe you had some small part in its construction and development in Omaha.

Mr. Daly. I did not realize that; but, I am glad to hear that the

graduates of Creighton are out in the world.

Mr. RYAN. We have infested the whole world, I think. That was the whole idea of building the place anyway.

And that brings us right back to our prime interest today. You may

go ahead; the committee is yours.

Mr. Daly. My remarks, Mr. Chairman, will be directed to the following specific points: First, we should delay no longer in launching a high priority, national action program designed to achieve a nation of energy efficient buildings within 15 years. This is true because of the growing national need to conserve energy; the current and projected dollar drain associated with the purchase of foreign energy supplies; the size and significance of the potential energy savings; the near-term technical feasibility for achieving conservation which can be within our grasp if we can organize our economic, political, and institutional structures in order to capitalize upon it; the economic reasonableness and feasibility of such a program; the administrative feasibility of such a program; and the qualitative benefits which will accrue to the Nation as a whole and to millions of individual citizens.

Second, the current approaches, as I see it, will only result in further indefinite delay, which may cause us to miss much, if not most,

of the conservation potential offered.

Third, the missing ingredient in current efforts is effective and

sustained leadership which can mobilize the needed actions.

My first point is that the Nation will pay dearly if we continue to delay launching a high-priority, national program to achieve a nation

of energy efficient buildings within 15 years.

There is increasing agreement among energy policy analysts that the Nation will experience growing energy supply problems in the years ahead. This will be true even under the most optimistic scenarios for large-scale breakthroughs in nuclear power or in other forms of centralized power generation which will not be reliant upon nonrenewable resources.

We already have been provided with some relatively painless previews of what such a situation will mean. Those previews included more than the highly visible inconvenience of long gasoline lines: Plants were temporarily closed; as national priorities for allocating scarce resources were drawn up, some industries faced the specter of possible long-term shutdown due to their low priority status; individuals were urged to reduce their comfort levels by turning thermostats up or down, or by reducing lighting levels; in some situations, individuals were also urged to restrict their travel. In addition, the cost of energy rose dramatically. And there appears to be no end to the continuing cost-push inflationary spiral.

Yes; Mr. Chairman, we have been afforded ample evidence that the growing shortage of energy will not be an easy matter. We know well that if similar and more painful crises are to be avoided in the

1980's and 1990's, we must begin to act now.

Energy conservation or energy efficient buildings, however, remains largely an untapped potential despite the fact that they offer a greater amount of energy savings, realizable in a shorter time period and at a better economic return, than almost any other energy investment dollar which we could expend.

Let's briefly look at what this means.

If all of the Nation's buildings which are projected to be in use in 1990 were converted to energy efficient buildings, a conservative estimate is that we would be saving the equivalent of over 12 million barrels of petroleum per day. This saving is approximately equal to the optimistically projected supply or energy generating capabilities of the entire domestic oil industry, coal, nuclear power, or both imported and domestically produced natural gas.

These savings could begin almost immediately, starting at a level of the equivalent of nearly a million barrels of petroleum per day within the first year, and adding an equivalent amount each year until the full potential is reached. Moreover, once the energy-saving capability is installed, the savings continue to accrue for the many decades

which buildings normally are retained in use.

We have heard many explanations for why energy conserving design and management techniques and low-intensity renewable energy technologies such as solar energy cannot be rapidly developed and deployed. One of the key barriers is that such energy cannot be relied upon for 100 percent of the energy needs. Hence, hookups to centralized electrical, gas, fuel oil, or coal systems are still necessary.

Another key barrier is that in some areas, the current cost of fossil fuels are still low enough that savings generated by energy conserving techniques will not pay back the investment within less than 5

years or perhaps even within 10 years.

Still a third key barrier is that we do not have appropriate institutional structures to integrate an energy system which would emphasize energy efficient buildings.

But, Mr. Chairman, please note that there is much agreement that current technology could achieve at least the energy savings discussed

above if we could figure out how to get it into use.

It is also true that substantial capital expenditures will be required if we are to have energy efficient buildings. No one agrees how much. However, substantial capital also will be required to install the generating capacity required to produce energy which could have been saved. I believe the following summarizes the economics of the matter:

Capital investment of about \$415 billion will be required to generate and supply to buildings the equivalent of 12.5 million barrels of

petroleum per day in 1990.

The cumulative cost to the consumer for this unnecessary energy over the 15 years from 1975 to 1990 will range between \$892 billion and \$1,499 billion. Remember, Mr. Chairman, that this cost will be spread among virtually every family in the Nation, and it will affect the discretionary personal income of virtually every citizen. It represents money unnecessarily spent to consume unnecessarily large volumes of the Earth's nonrenewable resources, most of which contain substantially greater value even today, if used for purposes other than to supply low-intensity energy. There is no way to estimate the value of such resources as future technological development

unfolds. We can only know that the costs of such lower scale utilization will be astronomical.

Mr. Ryan. May I just break in here to say that if we don't spend it then for capital outlay, we will spend it by wasting heat and energy through the air.

Mr. DALY. That is right.

Making all buildings energy efficient by 1990 will require additional capital investments of between \$729 billion and \$1,460 billion. However, if we could "credit back" the \$415 billion required to generate unnecessary energy, the net additional capital requirements are only \$314 billion to \$1,045 billion spread over a period of 15 years.

We apparently are approaching a period in which capital will be increasingly scarce and expensive. Energy efficient building investments will repay themselves in somewhere between 10 and 18 years. Once paid for, these investments will continue to contribute savings indefinitely. After the system costs are fully recouped, they will continue to pay for themselves over and over each 2½ to 3 years.

Moreover, the investment of these dollars in energy efficient technologies will make a highly positive contribution to long-term stable employment in an industry whose unemployment rate remains well above the average and whose capacity is poorly utilized. Estimates in the attached documents show that the energy efficient buildings program could stimulate the creation of over 2 million jobs and sustain them for a 15-year period. This, too, affords a greater economic advantage than the far lower levels of employment involved in centrally generating 12.5 million barrels of equivalent energy per day.

Finally, there is the question of whether the National Treasury could afford tax incentives and other costs associated with a program to achieve energy efficient buildings within 15 years. Once again, Mr. Chairman, our reason is constrained by our narrow vision. Estimates in my accompanying documents suggest that under very reasonable participation rates by building owners throughout the Nation, the National Treasury would experience a net gain rather than loss over the first 5 years of the program. It also should be remembered that the longer we delay, the greater will be the outflow of our national wealth to purchase foreign energy supplies.

Could the Nation or its citizens make a wiser choice than to find ways to convert these opportunities into actual savings? Is not this a highly advantageous political opportunity? Would not the American people welcome leadership which led to this type of future in which our comfort at home and at work is made at least as secure as feasible, rather than one in which our personal income is diminished as energy

costs consume more and more?

Mr. Chairman, would not our citizens respond to a vital leadership which would carry them in that direction; or will they not ultimately demand accountability from a leadership which has failed them once the missed opportunity becomes obvious and the pressure

of energy problems becomes greater?

It is often said that we cannot tap this potential because our political and economic systems are inadequate. It is alleged that we are so shortsighted or selfishly constrained to narrow dimensions of profit that we cannot develop the administrative capacity to capitalize upon the potential of energy conservation. While such statements may be

accurate observations of how we are now operating those systems, they are not true if they allege the systems themselves cannot be made more

responsive.

It is true that some institutional innovations are needed, but it is also true that we have an ample supply of flexible and proven institutional and economic concepts which can be packaged to provide the administrative/logistic capacity to realize the potential of a nation of energy efficient buildings. While neither I, nor do I believe anyone, can supply all the details of what is needed, the documents which I have brought with me outline a strategy for getting started and suggest programs which, if pursued, will result in our discovering just what will work.

These suggestions, Mr. Chairman, are more practical than theoretical. I recognize that we must learn and discover the final details

by doing, not theorizing.

Finally, I think we should not overlook the broader, more qualitative and more philosophical importance of finding ways to convert our economic and social incentives toward the encouragement of more responsible stewardship of the Earth's resources. Energy marks only one of a growing number of critical nonrenewable resources where we are beginning to experience a new form of economic scarcity—a scarcity dictated by our ability to acquire more than we can afford because we are pushing the limits of natural supplies, rather than the more traditional scarcity in which we could not get the resources which were critically needed, and in which our cumulative exploitation of natural resources did not so clearly threaten future needs. Successful innovations, showing how our democratic, private enterprise, and profit-incentive system can be mobilized to deal effectively with such problems, will make substantial contributions to the survival of dearly held and important values in the years to come.

My second point is that as I see the current situation, we are likely to delay indefinitely, and may even miss entirely, the realization of

most of this potential.

This judgment is not meant to detract from the many significant and encouraging initiatives which have been taken to place greater emphasis upon energy efficiency in buildings. Some of the enacted and pending legislation points up a rising consciousness of the need to move ahead in this vital area, and much of this legislation contains needed and constructive steps.

As another example, the Energy Research and Development Administration has announced recently that, on a priority basis, energy conservation is now considered equal to the development of any alternative supply source. This is an especially encouraging development.

But, the key problem is that these efforts have not yet been organized into a coherent, comprehensive, and complementary action program designed to get the job done on a large scale and within a short time frame. For example, incentives designed to encourage building owners to install energy efficient technologies range from modest inducements for homeowners to proposals that we should let the price of energy rise even more rapidly—possibly through energy taxes—in order to use high prices as a rationing device or as the incentive to make building owners come through. Surely, the severe penalties which will accompany such strategies should be limited only to situations where they are clearly unavoidable.

I am not qualified to say whether or not energy prices should be increased. Rather, I am saying that forced price escalation designed as the main mechanism to promote conservation is less desirable than the more positive alternative of making potential savings more attractive in the short run. This latter alternative will help offset the otherwise natural economic tendency to put off the issue for the next several years. To the degree that we can reduce the penalties of high-priced energy, our Nation and all of its citizens will be better served. And there are more positive alternatives. They are well outlined in the

accompanying material.

Another facet of current initiatives is the contention that the only way in which to stimulate the design professions and building owners to install energy efficient capabilities is to enact coercive legislation in the form of mandated standards. In fact, the current administration's energy strategy, supported, I think, generally by the Democratic majority in the Congress, is to spend the next several years developing energy standards for buildings and then mandating those standards in the form of required Federal legislation. While such standards are evolving at the national level, many States also are moving ahead on their own initiative to enact energy standards as a part of their building codes.

These are well-intentioned efforts, and they undoubtedly will result in capturing some of the potential energy savings. I believe, however, that on balance this mandatory standards and regulatory enforcement approach will result in far less savings than would a more positively oriented incentives approach. In addition, I believe that the administrative difficulties which inevitably will accompany further extension of such complex governmentally regulated activities will increase substantially the cost and the frustration of construction for everyone.

Finally, there are various legislative proposals to stimulate much broader incentives, and to establish special capital fund accounts to make energy conservation more achievable. These efforts point, I believe, in the right direction, but they too are relatively narrow and inadequate to accomplish far-reaching conservation goals.

Thus, my third point is that we have a missing key ingredient to the mixture. We need effective and sustained leadership which can and

will mobilize the entire Nation to the needed actions.

Mr. Chairman, it has been 3 years since, in its first report on the potential of energy efficient buildings, the American Institute of Architects called upon the national leadership to join in developing an urgent, comprehensive, high priority national program to achieve a

nation of energy efficient buildings.

Other individuals and groups also were beginning to urge such actions even then. The number of persons who recognize this need has grown dramatically during the intervening years. The dimensions, nature, and reality of the problems have become clearer, and some encouraging actions have been taken. However, we still lack the spark that is required—the kind of leadership which makes a nation of energy efficient buildings by 1990 a declared national goal, and which mobilizes a strategy and action program to bring it about.

The opportunity is real, but it is slipping through our fingers. The solution is within our grasp, but we continue not to grasp it. I believe, Mr. Chairman, for all of the reasons outlined above, that

the time for action is long overdue. We should delay no longer in declaring our full-fledged intent to get this job done for the good of the American people of today, and the even greater good of those to follow in our footsteps. I sincerely hope that you and this committee can help to become a rallying point which can and will provide the needed inspiration, comprehensive strategy, and stimulus for effective, sustained leadership.

I thank you again for the opportunity of sharing these thoughts

with you, and I welcome any questions which you may have.

Mr. Ryan. Thank you very much, Mr. Daly, for an extremely comprehensive and effective presentation. Perhaps I say that because I believe thoroughly and agree completely with what you say. This is

exactly where we have to go.

I have a couple of questions. One has to do with the fact that there are so many industries which are reluctant to get into really significant changes in energy policy if they are required to wait for up to 15 years, as you suggest, before they get the return. They want a faster return than that.

Do you have any comment on that? Is there anything we can do to

improve that thinking?

Mr. Daly. I would think that some sort of incentive program to assist those industries that will be required to make changes and would have to wait for 15 years would be in order.

Mr. Ryan. Do you mean through a tax writeoff or some change in

the structure?

Mr. Daly. Either a tax writeoff or assistance in payment of the costs of reconverting.

Mr. Ryan. Do you have any comments about ERDA's present approach and the way it is moving now with regard to this problem? Mr. Daly. It is my opinion, from my limited knowledge of what

ERDA is presently doing, that they are on the right track.

But I think that they were on the wrong track for a long time when they were expending all of their funding in the direction of new supply.

They now have declared an intention to rank conservation as just as important as any source of supply. They should be encouraged to

stay on that track.

I think it is important that we expend the early-on funds that are necessary to develop a program. And the problem is of such a size that only the Government can tackle it.

You touched earlier on the real key to getting the job accomplished. That key is to make people want to accomplish it. That is the most

important incentive.

For years, we were somehow or other made to want to use more energy. We doubled and redoubled and redoubled our use of energy every 5 years in this country. So certainly if we were made to do that, somebody ought to be intelligent enough to turn it around and make us want to use less.

Mr. Ryan. I am concerned about what I call the cave dwelling philosophy. In fact, just the other day I read a story in the paper about a man who said that his home was too expensive. He then spent \$30,000 to dig a hole in the ground. And he says that the temperature won't vary there from a range of something like 68 degrees to 74

degrees during both winter and summer. And he says that he is a lot better off.

Of course, since the earth is an excellent insulator, there is something to that. The salt caves in Kansas have been used for the storing of all kinds of sensitive materials because of the constant temperature there. And we are all familiar with the use of caves for storing wine because of the even temperature.

The point I am getting to, however, is: What has the AIA done, or what is it doing now, with regard to the construction of buildings out of materials which are energy cheap; that is, materials that require

the least amount of energy for manufacturing?

If the materials from which you are building your house or your building take only one-third of the energy that some other kind of material might use, would architects themselves be more prone to use

those kinds of materials?

Mr. Daly. Yes. But it is an educational problem which we have to get into. In answer to your question of what we are doing, I am afraid that we are not doing enough. But the leadership of the American Institute of Architects is very much aware of this problem. They are desperately trying to mobilize the interest of the profession and of the engineering profession to see to it that we do start regarding energy in all areas.

There is a whole front end of energy before it ever reaches the building. The materials that have to go into a building consume a great deal of energy in their manufacture and in their construction and in

the placing of that material into a building.

Slowly, we are getting this message across. But for years, at the university level, we have taught a system of being wasteful with our energy.

Mr. RYAN. It didn't matter. The only criteria was that it be func-

tional and attractive.

Mr. Daly. Yes, it added to the gross national product, and it was unpatriotic not to use energy.

Now we are faced with the fact that we have to start using our

energy more efficiently and more effectively.

Mr. RYAN. Is the information on hand already, or does there have to be research, to find out what kinds of materials are most energy effective in the front-end sense, as you refer to it?

Mr. Daly. I am sure there is a great deal of material on hand; but,

I think a great deal of research must be done.

Mr. RYAN. It has not been brought together yet, has it?

Mr. Daly. It has not been brought together.

Mr. Ryan. Am I correct in assuming that this would be one of the areas, among others, where ERDA itself could conduct the research or farm it out under grants to appropriate schools of architecture and engineering and so on?

Mr. Daly. I would think that would be highly desirable.

Mr. Ryan. I would like to ask the staff right here at this point to make some notes regarding this and to see what we can do to bring in the necessary information about what is being done to ERDA to get into and develop a measurement of energy efficient materials from the manufacturing standpoint.

I have one more question here. What about transportation and AIA?

Mr. Daly. Transportation is a very important element of the built environment—how you group the homes of people; where they work. We have a great tendency, I think, in this country to live in one end of town and work in the other end of town.

I think we are going to see a whole new generation of building environment. It is going to be oriented toward housing people close to where they work—maybe within walking distance.

Mr. RYAN. Is AIA moving in that direction now?

Mr. Daly. We are moving, but not rapidly enough, I would grant

you. But we are moving into that area.

Mr. Ryan. I am a typical energy consumer from the last generation. I live about 20 miles outside of town and I drive back and forth every day. The cost of the gasoline is high; it pollutes the air; the oil itself must come from a foreign country—which causes us to be much more vulnerable from the foreign policy standpoint; and the automobile itself costs an enormous amount of energy to manufacture. All of this could be done away with if I could live in this same building and ride back and forth in an elevator. Those are the two extremes.

And I would think that the AIA could, as you say here, assist, in the leadership sense, in developing and publicizing and making known to Members of Congress or those in other influential positions suggestions which you have for resolving the whole problem of transportation through building design.

portation through building design.

Mr. Daly. We are trying to move in that direction. Our resources are limited. The problem is so big that we are not being as effective,

I am sure, as we all would wish we could be.

For one thing, I think this goes way back into our educational system. We have to start with the educational system with the young engineers and architects whom we are training at our universities. And they have to be trained not only to think of creating energy efficient buildings as a unit, but of all of the materials and the manufacture of those materials that go into that building. Also, how the building is placed in relation to other buildings is important. All of these matters should be thoroughly researched. And then our new, young engineers and architects coming into the system should be trained at the university level in ways that are efficient in the use of energy.

Mr. RYAN. Is the AIA trying to get ERDA to recognize this par-

ticular area?

Mr. Daly. I am sure the AIA is working closely with ERDA in trying to do what they can. But it is a problem that is bigger than the American Institute of Architects. It is bigger than us all.

Mr. RYAN. I realize that.

Do you have questions, Mr. Gude?

Mr. Gude. To that end, what is the American Institute of Archi-

tects doing with the universities across the country?

Mr. Daly. They have a program of working with all of the universities in providing them with materials and holding seminars and trying, in conventional ways, to see that the educational system is changed to the point where it does produce a more energy efficient building environment.

Mr. Gude. Have specific courses been instituted in any colleges or

universities in these disciplines?

Mr. Daly. Yes; you are starting to see these show up at the university level. There are courses pointed directly at city planning as it relates to energy efficiency; construction, as it relates to energy effi-

ciency. But it is slow in starting.

I wish that I could tell you that all of the universities are on the track now. Some of the universities have adopted courses that are geared to the efficient use of energy; others have not adopted them as yet. And they should all be encouraged to adopt them as rapidly as possible, and get as much guidance as possible.

Mr. Gude. Does the American Institute of Architects have an awards

program for design?

Mr. DALY. Yes; they do.

Mr. Gude. Do they have a program for the recognition of energy conservation?

Mr. DALY. They do.

Mr. Gude. What about the utilization of waste heat from powerplants? Has any research been done by AIA in this area? Is there potential here?

Mr. Daly. Yes; there has been a good deal of research done in this area. It is economically feasible, in many cases, to take the waste heat and to extract additional energy out of it after it is used to produce

electricity.

In many cities, you will find that the power company is in the business of selling chilled water which they generate from the waste steam which they used to waste. Or they might be in the business of selling

steam to buildings in the core area of a city.

So there is a good deal of work going on in this area. I suppose it is not as effective as it should be; I suppose it could stand a lot of improvement. But it is a recognized fact that there is additional value in that steam that is wasted from electrical powerplants.

Mr. Gude. You recite in your statement some significant figures

about the potential savings that might be achieved.

Could you give us the source of that material.

Mr. Daly. They come from a variety of sources. You will find all of the sources in here. We took all of the studies that had been made in energy to this point and utilized them in the preparation of this report.

Mr. Gude. And this has a bibliography that lists all of the sources.

Mr. Daly. Yes.

Mr. Gude. Thank you, Mr. Chairman.

Mr. Ryan. Thank you very much, Mr. Daly. Your remarks have been extremely useful to me and to the committee.

I hope they will have some significant effect as time goes on. I agree with you in that we have got to get going now, and not later.

Thank you very much.

The next witness is Mr. John P. Eberhard, president of the AIA Research Corp.

STATEMENT OF JOHN P. EBERHARD, PRESIDENT, AMERICAN INSTITUTE OF ARCHITECTS RESEARCH CORP.

Mr. EBERHARD. Good morning.

Mr. Ryan. Good morning. Would you please state your name and occupation for the record.

Mr. EBERHARD, I am John Eberhard. I am president of the American Institute of Architects Research Corp.

I have prepared testimony, Mr. Chairman, which I would be happy

to submit for the record and then to summarize for you.

Mr. Ryan. After looking at the time, Mr. Eberhard, the committee would appreciate your making whatever comments you care to which will give us additional thoughts on the matter. And your entire statement will be placed in the record.

Mr. EBERHARD. In my statement, I argued primarily about four things. I suggested that there was a way of organizing research and development, of which I am sure this committee is well aware, and

which I simply outline as a way of getting into the subject.

I then discussed research and development specifically as it related to energy conservation in the design of buildings. I made some suggestions, particularly about the applied research area there.

In the third section, I presented some arguments, which again, I think this committee would be familiar with, of the differences between the public and private support of research and development. I did so believing, I hope correctly, that since this committee's function is one of oversight, that you would be concerned about the appropriateness of the kind of research undertaken by Federal agencies with respect to the need for public support as contrasted to private support.

Finally, in the last section, I dealt with what is obviously my personal opinion of the research activity going on in various Federal

agencies right now.

If you would like—again, on the assumption that your function is oversight—I could go over those brief remarks.

Mr. RYAN. You may.

Mr. EBERHARD. I would begin by emphasizing that from my observations, the Office of Management and Budget is overmanaging the process of energy research in the Federal Establishment at the present time.

Mr. Ryan. What do you mean by that?

Mr. EBERHARD. They appear to be, in those programs with which I am familiar, not providing sufficient staff allowances to the technical groups of either ERDA or FEA; or, in some cases even HUD, to carry out the programs which have been mandated by Congress.

The result of this is that congressionally mandated programs which place heavy emphasis on energy conservation and solar energy are being inadequately staffed and are not able to wisely and intelligently spend the funds which have been allocated by Congress. This in turn gives the Office of Management and Budget an opportunity to go back and suggest that maybe they do not need the funds.

Mr. Ryan. Could you, if they are being underfunded, suggest areas

where they are being overfunded?

Mr. EBERHARD. Yes. There are areas that I think are overfunded. Let me correct that. There is probably not overfunding available at the moment to any of the conservation programs.

If I were making the decisions—which I am not—I probably would spend those funds differently, as I indicated in my testimony.

Mr. RYAN. Let's stipulate that there is no money being misspent, but that wrong or inaccurate priorities are being assigned.

Mr. Eberhard. From my value system, that is correct.

Mr. Ryan. And in your value system, how would you change it?
Mr. EBERHARD. The primary emphasis which I suggest in my testimony is that I believe most of the research now going on in the area of building conservation is oriented toward what I call the great misconception here in Washington. That misconception is that buildings use energy because they have mechanical and electrical equipment in them.

If you believe that, then the nature of the research program you would organize would be to increase the efficiency of the equipment, to invent new kinds of equipment, to turn down thermostats. And these are the kinds of things that are, by and large, going on.

I argue, and I think that anybody who thinks about the problem for very long would probably agree, that the reason that buildings use energy is that people use those buildings. And it is the human activity that goes on in a building—whether it be holding a hearing in a congressional office building or educating children in a class-room—that requires some kind of modification of outdoor climate to a comfortable circumstance.

We have become in this Nation, as Mr. Daly pointed out, very accustomed to extremely comfortable circumstances. The result of this, I am afraid, is that many of us in the architectural business have been

making not very sensible design decisions about buildings.

We design a building that does not recognize the climatic factors that impose a load on it. And we compensate for that nonsensitive design by putting in large mechanical and electrical equipment. For example, we put in equipment to cool a room such as this when we might be able to open, on this nice day, the windows and do what we did 50 years ago in Washington—use breezes and fans, including hand-

operated fans.

So if one understands, as I am arguing, that buildings use energy because of the human activity that is going on in those buildings, then a different kind of emphasis begins to emerge. It is one of looking at the kinds of activities—education, hearings, office work, or living in a home—and of looking at the kinds of comfort support that is needed for that as well as the kinds of alternative solutions that are available to provide that comfort. And, as I indicated, these include a lot of the things we used to do, such as opening windows or letting it get cold at night and putting another cover on the bed. Or, as you suggested a moment ago, we could walk to work if we only lived two blocks away; or, we could conceivably go up and down a stairway in a two- or three-story building instead of riding the elevators.

Mr. RYAN. I refer to them as the elevator commuters.

Mr. EBERHARD. That is right.

We also would look at an area which, as I suggest in my testimony, seems not very well supported at the moment—which the National Science Foundation might very well be an institution of the Federal Government to support—and that is the whole area of the social and behavioral sciences.

Because energy use is the result of people using buildings, we ought to understand better, I think, than we presently do the way that people interact with buildings: the way people are affected sociologically and psychologically by buildings. A subject which I understand you are interested in, that of multipurpose or multiuse buildings, certainly has that dimension to it.

If we are going to use educational buildings for other community functions or if we are going to use a Federal office building in the evening for continuing education programs here in Washington, for example, we have some problems to deal with that are not just technical issues in the mechanical and electrical equipment. We have a number of problems to deal with which involve the organization of human activities.

And, by and large, my criticism of the present programs is that those

kinds of issues are not being addressed.

With reference to the issue which you raised with Mr. Daly, by the way, for informational purposes, there is some research in ERDA with regard to energy use in materials. An architect in New York City, named Richard Stein, has a contract from ERDA. The work is being done with a man by the name of Bruce Hannon at the University of Illinois, and specifically looks at the amount of energy that is required to produce various kinds of materials that go into buildings.

Mr. RYAN. That is the kind of thing we are interested in.

Mr. EBERHARD. The Department of Commerce also made a study a year ago of the amount of energy used in the construction industry. And that, I think, is narrowly conceived. They have looked at how much energy it takes to operate the equipment on a construction site—such as derricks and hoists and earth-moving equipment and trucks.

I pointed out to them, which of course is obvious in hindsight, that they begin the first paragraph of their report by talking about the 4 million construction workers. If you do a slight back-of-the-envelope calculation about how far the construction worker drives to work every day, and if you assume that he gets 15 miles to the gallon on an average in his automobile, you find out that the amount of energy used just to get construction workers from where they live to the site exceeds by some order of magnitude the amount of energy that is portrayed in that report as being used by the construction industry. That report was limited to the construction site energy consumption.

It does not look at the question of all of the energy that has been used to take the trees out of the forest or the ore out of the ground and to produce the building materials in the first place before they arrive at

the site.

Mr. RYAN. We don't even have a kind of current currency to use for measurement. How much energy is required to make a ton of high-grade steel or the kind of steel that is used in a building, for example?

Mr. EBERHARD. I cannot quote you that number, but I think that

number is known. I have seen it.

Mr. Ryan. How is that expressed?

Mr. EBERHARD. It is expressed at Btu's of energy. Everything can be converted to Btu's, whether it is electrical energy, gas energy, or whatever.

Mr. RYAN. Mr. Gude.

Mr. Gude. Have there been any studies of covered malls, which create an artificial climate, which compare the efficiency of those malls with the efficiency of as opposed to open shopping centers which have the same square feet?

Mr. Eberhard. There has been some recent looking at that, Mr. Gude.

I assume you mean that from the standpoint of energy?

Mr. Gude. Yes.

Mr. EBERHARD. In fact, the most recent issue of the AIA Journal has a series of articles on public spaces that are covered like that, and that are primarily inside of buildings. The new center recently opened up in Atlanta is an example. There is one in Minneapolis.

I do not know of any results, although that does not mean it has not been done, of looking at that from the energy standpoint. Since there is the possibility that people are more comfortable, energy, of course.

is usually required to provide for that comfort.

Mr. Gude. It isn't necessarily accepted that they are automatically inefficient and ineffective; is it? There is a certain amount of savings in the consolidation of buildings into one unit, so that there is not the heat loss, for example, that you would get from individual buildings or separate units where the ingress and egress would only be through the outdoors.

Mr. Eberhard. That is not generally accepted. But I think it ought to be generally understood that if those kinds of areas were covered, particularly in cold climates such as Buffalo, N.Y., where I lived for 5 years, you would not necessarily have to heat or cool the entire area.

We once advocated, when I lived in Buffalo, that the university's buildings be connected by at least a covered walkway. You would not necessarily have to heat or cool those areas. But the very fact that they connected buildings to each other would avoid the kind of energy losses that occur by infiltration when the doors are opened and closed a thousand times every day by people coming in and out of the buildings.

Mr. Ryan. Let's carry that one step further. Is anything being done in the AIA, or in any of the organizations which you have mentioned, with regard to the kind of thing which Mr. Gude talks about?

In the area of the Montgomery Mall, which is the area in which I live and which is a part of Mr. Gude's congressional district, they continue to construct more and more retail stores, second-story parking places, and so on in order to attract more and more customers who come by car from a larger and larger surrounding area.

But the cost of that real estate around it continues to go up because of that. And there will be a point at which the cost of the real estate reaches the point of impossibility as far as the ability of the people to buy residential or apartment dwellings. And the thing will continue to change still further if we continue under the present system.

If we look into the future, then, is there any logic to my own conclusion that the next step in the evolution of American cities is up?

Does that make any sense architecturally from an energy standpoint?

Mr. EBERHARD. I could modify your image slightly. Your image is that "up" is the way you increase density. I think your performance requirement is that the use of the land becomes more densely occupied. And one way of doing that is to build buildings higher in the air.

There are a number of other ways that can be done. And that is a

problem that interests a number of architects.

Mr. Ryan. From an energy standpoint, it seems to me that if you do not have to have an automobile and you do not have to have the expenditure of energy for that automobile, and you do not have to have the petroleum expenditure of energy required to push the automobile around, energy would be saved.

Is there any logic, as far as the Federal Government is concerned and as far as we are concerned, in trying to move in the direction of constructing a complex such as the John Hancock Building in Chicago perhaps, with a little more imagination as far as the social sciences end of it is concerned?

Would that not, as Mr. Daly indicated, reduce the consumption of

energy at the front end?

Mr. EBERHARD. The performance requirement, I would fully agree with. I think that is what you mean. We reduce the amount of energy required to operate our lives by reducing the amount of travel we have to do from where we work to where we live. Presumably, therefore, we

are increasing the density of the places in which we live.

It is not necessarily correct that the best way to resolve that problem, or the only way to resolve it, is to build more John Hancock buildings. Buildings of that kind are enormous energy users for one thing. So there is a tradeoff that begins to occur of how much energy it takes to build and operate a building of that kind versus alternative solutions.

Mr. Ryan. When you say there is an enormous energy consumption for that kind of building, are you considering that simply in terms of the gross amount required to run the building?

Is there any kind of measurement which compares the expenditure of energy of that building as opposed to a residential community around

an industrial or commercial area?

Mr. EBERHARD. If you look at an area such as southeast Washington, the area around the Arena Stage, where there is a fairly high density of dwelling units per unit of land, and if there were more Federal office buildings—and there are some—so that people could live and work in that same area, the amount of energy that would be required there would be considerably less than a solution such as the John Hancock Building.

If you compare the John Hancock Building to the circumstances in which I, and apparently you, live, where we live 20 miles away from where we work; and if you consider that our energy consumption patterns, therefore, are based on an automobile as the connecting link, then it is true that the people who live in the John Hancock Building are using less energy. But the amount of energy used per square foot

of building in that building is fairly high.

Mr. Ryan. This brings us back to the original point which I raised. When talking about energy consumption, it would be most important for the Federal Government not to simply pursue closing the windows or making the walls more thermally efficient or turning off lights, but to begin looking at the siting of buildings.

Mr. EBERHARD. That is right.

Mr. Ryan. Also, consideration has to be given to the materials of which buildings are constructed, the location of the kinds of workers who will be in the buildings—whether they are within walking distance—and the nature of the construction of the residential areas themselves.

If it isn't John Hancock and it isn't the single-family residences 20 miles out, but if it is the smaller, box-like units that are most acceptable and most efficient, should not then the Federal Government be deeply involved in studies that indicate that?

Mr. EBERHARD. I think that they should. I have suggested, and I think you are confirming, that if we begin with people and the lifestyles that we lead and the kinds of activities that we are engaged in—our work, our private lives, and our public lives—and look at the kinds of supports needed for those activities; and if we look at how comfort conditions can be provided by natural means for those, then we are approaching the energy question with a different perspective than if we begin by assuming that energy all has to do with mechanical and electrical equipment and, therefore, all of our research programs should be organized around increasing the efficiency and/or effectiveness of that equipment.

Mr. Ryan. I deeply appreciate your appearance here, Mr. Eberhard. I think we may be off in the right direction. I am very anxious to keep in touch with you and to pursue this matter as far as we can,

with your assistance and advice upon occasion.

There is a vote on the floor; and since I am the only one here, we will have to adjourn at this point.

Again, I thank you for being here.

[Mr. Eberhard's prepared statement follows:]

PREPARED STATEMENT OF JOHN P. EBERHARD, PRESIDENT, AMERICAN INSTITUTE OF ARCHITECTS RESEARCH CORP.

Mr. Chairman, my name is John P. Eberhard. I am President of the AIA Research Corporation, a not-for-profit public benefit corporation established by the American Institute of Architects. I come before you as a professional experienced in energy matters, but not today as a spokesman for the American Institute of Architects.

Since World War II, we have been convinced as a nation that research and development are appropriate and effective methods for solving problems. As a consequence, we have developed a large number of institutions and organizations who are engaged in research and development, and we have produced thousands of university graduates who expect to spend their professional lives working in research. Last year more than \$34 billion of public and private funds were invested in "R&D." Now that we have become concerned with the supply and conservation of fossil fuels, it is natural and right that we utilize these twin problem-solvers of research and development to explore possible solutions to our national problem. In what follows, I would like to do four things:

(1) Discuss, by way of background material, the general organization of R&D

in the United States.

(2) Suggest ways in which R&D could be organized to address the use of energy in buildings.

(3) Suggest some guidelines for the difference between public investment and

private investment in R&D for this purpose.

(4) Evaluate the current federal programs in the light of the previous arguments. (As an oversight committee, it would seem that your interests would be directly related to this latter evaluation.)

THE ORGANIZATION OF RESEARCH AND DEVELOPMENT

Research as an intellectual activity can be generally subdivided into basic and applied research. For the purpose of this testimony, however, I would like

to suggest six phases.

(1) The exploration and development of fundamental theories. Historically, major scientific discoveries have emerged from the discovery or establishment of such new theories. Examples would include the work of Copernicus in establishing the sun as the center of our solar system; the basic theory of Einstein that mass was interchangeable with energy; and, the basic theories (which became laws) of thermodynamics. This theoretical work can be supported and encouraged by financial support such as the programs of the National Science Foundation, but it can seldom be predicted in advance or accelerated by the massive expenditure of federal funds.

(2) Basic research which generally results in the addition of new knowledge independent of specific problems requiring solution has been primarily the province of universities and large research laboratories. In recent decades the scientific equipment needed to conduct basic research has become increasingly more complex and expensive. In basic areas of fundamental physics the investments have become so large that public funding is mandatory if new knowledge is to

continue to become available.

(3) The area of research which results in basic new inventions continues to be complex in terms of public policy debate. Outside of the major fields of space exploration, weapons systems and atomic energy, most of the major inventions are still the products of individual genius in the private sector. Federal patent policies, tax incentives and federal support of basic research provide a context that is important to private invention, but federal agency support of fundamental invention in civilian problem areas is considerably less effective than the market potential recognized by private industry. This observation would seem to be particularly important to new opportunities emerging in the energy field such as solar energy.

(4) The application of existing knowledge and technologies to new problem areas is generally known as applied research. It is in this sector of research that we find the most complicated issues of public policy. How much federal support, for example, will be required to broaden applied research efforts in energy conservation? Or, conversely, when is too much federal involvement likely to stifle the development of applied research in a newly emerging area of concern? (I would argue that federal agency involvement in energy conservation research is beginning to smother a new area of opportunity before it has had an

opportunity to be well organized or imaginatively expanded.)

(5) Once applied research has begun to produce new or improved concepts or technologies there is a stage of development during which the embryo ideas are tried out in practice and sometimes at a large scale. This can be a crucial stage of research. If too much is expected from the results of a demonstration, then the supporters will be disappointed when failure occurs-whereas failures should be anticipated and learning from the failures should be an important part of the research cycle. It is also generally a good idea to have a demonstration conducted by those professionals and institutions who will be responsible for utilizing the research results at the end of the demonstration phase, rather than awarding demonstration contracts to research institutions with little or no familiarity with actual working constraints. (In the energy field, there has been a tendency by this Administration to award energy demonstration contracts to large space or weapons systems laboratories or companies as a way of keeping such institutions alive even if they have little or no actual experience in the civilian markets eventually targeted for the results of the demonstration.)

(6) The final phase of the R&D cycle is the organization and dissemination of research results. We have in place now the capability of organizing this phase on a very large scale; however, we are much more likely to spend federal funds in the collection and distribution of research reports than in organizing the effective utilization of the results. There is also a tendency to organize all such information systems around the interests of the scientific and engineering

communities to the exclusion of other professionals or users.

RESEARCH AND DEVELOPMENT AND ENERGY USE IN BUILDINGS

Research, to be effective, should obviously be organized to solve problems correctly defined. A misconception of the nature or complexity of a problem can result in either solving the wrong problem or, worst still, aggravating the real problem by neglect or adding to the complexity. It is not easy to be clear on problem state-

ments, and many problems are surely open to debate.

For example, some people have defined the U.S. energy problem as being one of avoiding our dependence on foreign sources of oil. It seems clear that this is not only an unrealistic problem statement (i.e., that we will likely be able to avoid foreign oil imports in the future), but it tends to distort the nature of the solutions pursued. I would like to focus my testimony on the subject of the use of energy in buildings rather than the broader issues. Since buildings presently require about one-third of the energy used in the United States, this is a significant area of national concern-or it should be.

Most of the research oriented towards the conservation of energy in buildings is based on the misconception that it is the equipment for heating, cooling and lighting buildings that causes buildings to need energy. A different perception of the problem emerges when we recognize that buildings are intended to provide shelter for some human activity and that it is the comfort of the people engaged in such activity that produces a requirement for heating or cooling and that it is the requirement for people to see to conduct their activities that requires light. Historically we have had buildings that provided a measure of protection against heat in the summer or cold in the winter by the way they were designed, and by the addition of simple devices such as stoves and fireplaces. For most of the world, that is still true. Only in the last few decades have Americans become accustomed to having the interiors of their offices and homes heated and cooled within a narrow range of comfortable temperatures regardless of weather conditions or regardless of how insensitive the building design might be to climatic conditions.

If our problem statement for energy use in buildings is clearly based on the fact that buildings are designed to shelter human activities, the range of issues around which we will organize a research and development program will be much broader than one narrowly focused on a concern with mechanical and electrical equipment. Architectural issues such as the multiple use of buildings would, for example, be a potential area of exploration. Associated with such issues would be the sociological and psychological implications of multiple use, as well as the economics. Obtaining a broader mix of use for public school buildings could change the energy budgets associated with the activities that are included in school buildings independent of the energy efficiency of the mechanical and electrical equipment. Or, in another instance, if a Federal office building was used in the evening for adult education programs its energy requirements would be modified. Research issues associated with a problem statement based on human requirements for energy are, therefore, possible and needed.

PUBLIC INVESTMENT VERSUS INVESTMENT IN ENERGY B. & D.

In addition to the need for stating research problems with as much clarity as possible, there is also a continuous need to explore the balance between effective or appropriate public support of R. & D. This is especially true of the research phases beyond the development of theory and basic research. I have already mentioned some cautions with respect to federal investments in developing basic inventions in areas such as energy use in buildings that are essentially consumer markets rather than federal markets. Allow me now to suggest a few ground rules for the support of applied research by either public or private funds:

(1) It seems appropriate for public funds to be used to support conferences, seminars and studies which serve as forums for continuing public policy debate on the balance of interests between consumers and producers of energy. In fact, there has been a tendency for such debates to be conducted within the Executive Branch or between the Executive Branch and Congress and not in more public forums. A lack of support for research oriented towards conservation and conversely heavy support for improving the fortunes of those engaged in energy

supply R. & D. seems to be one of the results.

(2) Where the private risks are too large to provide adequate incentives for research support in the private sector, and where the public benefit from the results would appear to be clear, then federal funds should be used to support applied research. However, methods of removing some or all of the constraints to establishing an effective market for private investment should be explored before organizing a federal program to do the applied research within federal labs. It seems inappropriate to assume that federal agencies should be given the responsibility for applied research programs just because they have large underutilized facilities or staff.

(3) The development of the knowledge and methods required for performance standards and specifications needed to advance a new area of development such as solar energy seems an appropriate public investment provided it is well timed and open to all reasonable alternatives. Early closure on standards for a field not yet fully developed can stifle new developments, and, unfortunately

this now seems to be the case in solar energy.

(4) There is an obvious combination of public and private investment needed to collect and disseminate the results of research as broadly as possible. Again there is the caution of simply organizing such programs on a massive scale within federal agencies because they are looking for something useful to do.

OBSERVATIONS ON CURRENT FEDERAL PROBLEMS IN ENERGY R. & D.

While I cannot claim to be fully aware of all program plans and research interests of federal agencies presently undertaking R&D in the energy area,

I do have a firsthand exposure to much of the work. In what follows, I offer my personal observations:

The Office of Management and Budget seems to be overplaying its role in the energy area. In too many cases agencies have not been allowed to adequately staff for the size of the program intended by Congress, and consequently the funds do not always get spent wisely or well. This can create a cycle in which the agency is criticized for poor program planning and increases in program support are denied for the following year. Whether it is intentional or not, OMB is setting energy R&D policy for the nation by their over-management, and that policy is not favorable to programs of energy conservation.

The National Science Foundation has had most of their former responsibility for energy research transferred to ERDA. While a good deal of the basic research NSF supports will eventually find its way into energy problem solving, it would seem appropriate to have more directly designated funds within the NSF budget for long-term fundamental research of likely value to the energy area. This is particularly true of work in the social and behavioral sciences since such disciplines are almost entirely absent in the programs of ERDA and FEA

The National Bureau of Standards (with which I was associated from 1964 to 1968) has an enormous competence in fundamental science. To the extent that in-house basic research is required and appropriate for the government, it would seem to be wiser to support it there, than to foster competition between NASA laboratories and atomic energy laboratories to mount new programs simply because they are there. The National Bureau of Standards also provides the technical competence for the development of standards in the area of energy conservation. Unfortunately, the standards work now going on is limited by the misconception of energy use in buildings I mentioned earlier. When people trained in physics and mechanical engineering are asked to define a problem, it's not surprising that they see it in terms they understand, but it's too bad that discussions of need for energy standards before Congress tend to perpetuate these limited views.

The Federal Energy Administration seems to be in a uncertain stage of its institutional life. The program it has mounted for energy conservation in buildings seems to be the best balanced and broadest based federal efforts, but it has had a spotty history of support by OMB and the top management of the agency. FEA's program of conservation has been staffed from the beginning primarily by engineers, but it has had the additional perspective of economists

and architects in its top management.

The Department of Housing and Urban Development has put together an effective team of staff members to deal with the solar energy demonstration program mounted by Congress, but I see no equivalent effort to deal with the issues of energy conservation in housing much less the problems of energy use at the urban scale, HUD tends to be dominated by the interests of the Mortgage Banking Community, and since energy is not yet a high priority concern for mortgage lenders (in fact energy requirements are placing demands on scarce work capital in competition with mortgage funds) we will likely have to move much closer to a genuine concern with the life-cycle costs of housing not just the first cost, before energy conserving programs other than solar energy

become a significant concern of HUD's research program.

ERDA's programs of energy conservation and solar energy are not only the most prominent of the federal R&D efforts, but the most difficult for an outside observer to evaluate. My impression is that the much discussed dominance of the ERDA budget by nuclear energy programs (as contrasted to energy conservation and solar programs) is only a surface sympton. The much deeper and more difficult problem is the dominance of the thinking and planning within ERDA by those trained in the sciences and engineering. I don't mean to disparage these disciplines or to attribute poor intentions to ERDA management, but rather to raise the question of balance. If policy planners believe, for example, that buildings use energy because they have mechanical and electrical equipment and if the research staff is subsequently dominated by engineers and scientists, then it should be expected that most of the research would be organized around increasing the invention of new devices. The requirements of the people will either be ignored or subjugated to the efficient operation of the equipment.

Mr. Chairman, I have been openly critical of specific federal programs because I understood that such criticism would be most useful to this Committee. I would hope that those responsible for federal R&D planning will see these comments as constructive. I look forward to a period of national energy planning in the

near future that is oriented towards an understanding of human needs and requirements, and which as a consequence attempts to have federal policy represent not just the interests of the few, but the concerns of all of us.

Mr. Ryan. When we reconvene, we will hear Mr. Sant's testimony.

[A short recess was taken.]

Mr. Ryan. The committee will again come to order. We will go right into the matter at hand and proceed with Mr. Sant's testimony. Mr. Sant, will you identify yourself for the record, and then proceed

with your testimony.

STATEMENT OF ROGER SANT, FORMER ASSISTANT ADMINISTRA-TOR, CONSERVATION AND ENVIRONMENT, FEDERAL ENERGY ADMINISTRATION

Mr. Sant. I am Roger W. Sant. I am the former Assistant Administrator for Conservation and Environment of the FEA. I am cur-

rently a freelance consultant.

I guess my interest in energy conservation has become somewhat of a religious thing for me. And it continues to baffle me as to why there is little or no constituency for conservation. There is a lot of flag waving and arm waving, but really no commitment in any institutional form in the United States.

The last few years has brought a significant progress from where we were. The Federal Government alone found it in their power to save 30 percent of their energy bill. This, I think, is a stupendous accomplishment—given that the rest of the country has only saved some-

thing in the range of 2 to 3 percent.

The fact that we have legislation to mandate the fuel economy of new cars is something we ought to take credit for and be proud of. The fact that we have decided to give States money to promote conservation is also something that we should be proud of. That we have set efficiency standards on appliances is a fine accomplishment.

On the other hand, the fact that we do not yet have national building efficiency standards, the fact that we do not yet have tax credits for existing residential or commercial improvements, and the fact that we have not provided insulation for the poorer families all trouble me

greatly. I am puzzled as to why.

It seems to me that it is perhaps because there is no real constituency for conservation. If we only had the power in energy conservation that the nuclear lobby has or the oil company lobby has, or even the electric utility lobby, as examples, we perhaps would see significant money being expended on incentives and education because for the most part, Mr. Chairman, the cost per unit of energy saved through increased efficiency is substantially less than the marginal cost per unit produced.

That is, if you look at it by saying, "A barrel saved is a barrel produced," the cost of a barrel saved generally is substantially less than

the cost of a barrel produced.

So conservation is really a new source of energy that requires investment, that requires management, that requires engineering. And it is a commitment that, if we only had some institutional force behind it, could make a major difference in one quality of life in the coming years.

That concludes my preliminary statement. I would be happy to an-

swer any questions.

Mr. Ryan. I am interested in what you say we have done; but, as you are, I am more interested in what we have not done—given the size and the mass of the Federal bureaucracy. But I cannot agree with

you that there is no constituency.

It is true that there aren't demonstrating mobs outside waving flags; there aren't pickets in front of the White House with their particular cause. But if you compare the constituency there is for conservation with that of the nuclear or the electrical folks, I am much more optimistic than you are.

The fact that the conservation constituency is not as well organized in a financial sense only indicates that we have a little further to go.

That is all.

I am so totally convinced that nuclear energy is a passing phase, of much shorter duration even than petroleum or fossil fuel energy, that I hope to live to see the time when people complain because the solar energy lobby or the conservation lobby is so large and so powerful.

But I think what we are really talking about is a matter of leadership. People really do not know where they want to go because they have not been told where they ought to go. And nobody has done it yet.

And I can assure you that if you are one of those who feels some almost religious commitment, you have come to the right place. So long as I am around on this subcommittee, I intend, by any means that is legal and not immoral and not unethical—and I phrase it in just that way deliberately—to make noises as loudly as I can. And I will do it both here in the Congress and anywhere else I can do it.

What we are after though are some better answers. And that is why I would like to question you about where you feel the FEA, from your

own experience, is and has been short.

I am not interested in what they have done. They have done too little to warrant any kind of significant recognition in the congressional sense, or in the sense of meeting the needs of the American people.

Even if their heart is in the right place—if you will forgive me for

saying it—their energy has not been well spent.

I do not believe that the light bulb theory of conservation is where we ought to go. Turning off a few lights or turning up and down the temperature to adjust to climate needs is, I suppose, something. But I won't even go as far as you do in lauding the Federal Government's 30-percent reduction because I suspect, if we ever get that far in the limited time of this subcommittee's hearings, that we will find that the amount of training required for flight training, for example, has been curtailed past the point where it is comfortable.

And I suspect that we will find that the expenditure of necessary and useful maneuvering training of naval ships has been cut back past

the point where it is reasonably comfortable.

And I have a hunch that the large amount of decrease and what the Federal Government has been able to accomplish comes too much from that area, and not enough from rooms such as this very room right here. This room is too cold, apparently, for the women who are here. It is comfortable for me because I am more heavily dressed. And this is on a day when we are told that the weather outside is already pushing 90 degrees. That is a little ridiculous.

Having gotten past that point, I would like to know from you where you think the FEA could go in more positive and more useful direc-

tions-both short range and long range-and come up with better

programs?

I think they are too comfortable in their air-conditioned buildings. Perhaps they should be put in buildings that were not so well cooled until they are able to produce plans for better and more functional air-conditioning for everybody else first.

Mr. Sant. Without agreeing with you—which I don't—let me still

answer your question.

Ten million barrels a day are being used in existing buildings. And you really could say for the next 5 years, "I really do not give a darn about new buildings. All I want to do is improve the efficiency of existing buildings." And you could probably save 30 percent of that.

And if I were putting my priorities in a line, I would spend 90 percent of my time on existing buildings right now and 10 percent on new

buildings—just because it represents a bird in the hand.

Even by 1985, new buildings may, if we have fine economic progress in this country, will represent maybe 35 percent of the stock. By the year 2000, it may represent 50 percent of the stock. So the existing

buildings really ought to be the high priority.

And the simple things such as turning down thermostats, which may save 15 percent of a person's heating bill; or turning out lights, which may save 50 percent of an electrical bill for lighting purposes, are undoubtedly the places where we ought to start. That doesn't cost anything and it saves immediately.

In fact, the Government's own experience of saving about 18 percent in those two areas in its own buildings seems to be totally appropriate. I am looking at this outside of the question of military preparedness. I will not even try to comment on that; I think the military can suc-

cessfully do that.

Second, the FEA needs to get more information to each individual owner of a building and owner of a home, or occupant of a home, as to what the potential changes are which he can make in that existing building which will improve its thermal efficiency. You and I, as homeowners, need a list of things, coming from an authoritative source, which say, "If you put 6 inches of insulation in, you will save \$100 a year on your fuel bill. Or, if you put in stormwindows, you will save a certain amount."

My own view is that most of the emphasis right now should go into those kinds of things and should get as much information to people about existing technology, existing products, and existing changes that could be made. And that is where the FEA could profit from some substantially increased activity. The pending tax credit would be a

major stimulant.

The third area, then, would be to develop a performance standard for all new construction and have that mandated in all building codes. If that were done, we would simply answer all of the technical questions about efficiency on new construction. And that may be the best thing that we could do.

I guess the fourth area would be to make sure that we are getting that insulation into the homes of the poor. That will not save much energy, but it will surely save the heartache of the people who have

really been affected by these high energy costs.

So those things, Mr. Chairman, all should be accelerated by FEA. They should not only be accelerated by FEA, but they should be

accelerated by everyone. The legislation should pass Congress; the administration should approve the request of FEA for higher expenditures; the Appropriations Committee should at least approve the amounts that are proposed by OMB.

Everyone has a part in this. But, clearly, those four areas need to be accelerated in order to achieve the kinds of results of which you

are speaking.

Mr. Ryan. Do you think there is any need for FEA to examine or take inventory within the Federal Government as to what the present building standards are and what they ought to be with regard to substantial change not only of the buildings themselves, but of the effect that Federal buildings have upon the design of portions or all of a city, for example?

Mr. Sant. Yes. A little bit has been done; but, much more needs to be done. The GSA, through their program of building buildings, has really done more than anyone. They are now building two experimental buildings where they are trying to get to a performance standard of 55,000 Btu's per square foot. One is in New Hampshire; one is

in Kansas. And it looks as if they are going to make it.

That is roughly half of the current energy consumption. That just tells us that given existing technology, the Federal Government can probably turn itself around within the next couple of years with performance standards that it understands well enough to put into practice, and will probably save half of the energy used by new construction.

Now the thing that the Federal Government has not done is to investigate in any serious way the retrofit of existing buildings. If we went about looking for the ways of changing the existing stock of Federal buildings and finding ways of making them more efficient, it could run us into \$2 billion or \$3 billion of potential investment opportunities. And no one, at this point, has been willing to even consider that as a Government expenditure.

The FEA, during my watch, proposed that we essentially set up a \$2 billion budget for doing that over the next 5 years. And that may not be adequate. But it seemed appropriate. We did not, however,

succeed with OMB.

If we had, I am not sure we would have succeeded with Congress. But, nevertheless, if I were to put the highest priority on anything we could do now, it would be to retrofit every existing Federal building in any way that we now know how. This includes insulation; this includes storm windows; this includes much better heating plants; this includes much better thermostatic control.

The building we occupied at FEA was a monster. You would have one floor that was 65 degrees and one that was 95 degrees. And there was no way to control that balance. So it was an argument as to who

would be cold today.

If I were going to have a Wall Street Journal reporter in my office the next day we would really scramble to try to get my room so that it was the right temperature, But it was impossible.

If you just spent a little money to retrofit that building, incredible efficiencies could occur. But it is not going to come free. We have done all the free things.

Mr. RYAN. What about opening windows?

Mr. Sant. I don't know. I understood what AIA was saying. I have gotten all sorts of contra-testimony. People tell me that if you kept

the windows closed and recirculated air through a computer controlled system that you would be better off than having windows that opened. You could then control the amount of air that circulated from outside.

Mr. Ryan. If you had been able to open your window when, to use your example, the Wall Street Journal reporter was coming, would that not have helped?

Mr. Sant. It was just the opposite of that. He came during the winter and it was too hot. I did open the window. And it did make

the press.

I do not think that just opening windows is the answer. Obviously, that just lets the heat go out the window. It is not just the comfort I am worried about; it is the energy we use. And I think that we will probably find that if we could do a good job of controlling the air handling systems within a building that it may not be important to open the windows, but to have adequate control of the air that is being recirculated from the outside to the inside.

Mr. Ryan. And you say that it would cost \$2 billion or \$3 billion

to retrofit all Government buildings?

Mr. SANT. No one really knows because we do not have an ade-

Mr. RYAN. Is there any effort being made, or has there been any effort made, by the FEA to, on an inventory basis, decide what needs to be done to retrofit those buildings?

For example, has there been an effort which could say of the Rayburn House Office Building, in order to be energy efficient to a particular standard, which we have set, that it needs to do this and this and this, and the estimated cost is so and so?

Do you have any kind of computer printout that will tell us all of the Federal buildings we own and what it would cost to fix them up

to a particular standard?

Mr. Sant. That is a bad example because the House Architect controls this building and the Federal Government has nothing to do with it.

Mr. RYAN. Even the House Architect can be approached. It is a little like going to the Pope in the Vatican, but it can be done.

Mr. Sant. I suggest you try it sometime.

But in answer to your question, no; there is not. There was a provision in the Energy Policy and Conservation Act that required that, so it is underway now. And I am grateful for that.

Often the legislation helps. When an agency is arguing that that is what we ought to do, but has no funds to do it, it runs up against a

budget constraint.

When it comes down with legislative force and says, "Do this," you generally get funding to do it. So right now that survey is underway. And the GSA people tell me it will probably take something like 2 years to do a complete audit of those buildings. But they will start getting some on line and the budget recommendations will go in on those soon.

The same is true of the Defense Department, which controls even more buildings than GSA. They are beginning an audit of all of their buildings. The only reason they haven't up until this time is that they have made proposals to retrofit those buildings and have always gotten turned down on the requests when going through OMB.

So there is a tremendous job to be done.

You were saying that there is a constituency for conservation. Nevertheless, the Federal budget on energy now has about a 5-percent energy conservation component. And that is not much of a constituency anywhere. It is a peanut-kind of operation.

Even when we get a major conservation incentive proposal, as we now have in the FEA Extension Act, it calls for financial support that wouldn't save enough energy to even make us excited. It is going to

take a considerable strengthening of those ideas.

Mr. Ryan. Do you have any comment to make on why OMB is so

tough on all of this and so hard to get along with?

Mr. Sant. They are tough on all budget matters—and should be. The only problem I have with that is that they don't sort out investment budget items from operating budget items.

It seems to me that if we can invest \$2 billion and save that over a 3-year period, which looks highly likely, in energy costs, let's jump

in and do it.

Mr. Ryan. But if the boss is elected this year, or not elected this year, it doesn't do any good to talk about 2 years from now.

Mr. Sant. True.

Mr. RYAN. That is one of the limitations.

Mr. Sant. At the same time, I am not one to complain about OMB because it may be our fault for not doing a very good presentation

job.

Somehow, we have got to get better at convincing people that saving energy is not a change in life-style and all of those things that people are scared of. What it is just making appropriate investment decisions to increase the efficiency of those buildings and cars and so forth.

I was going to say also that when you mentioned that you have been added to the list, I think that makes five of us now who are religious

about conservation.

Mr. Ryan. I am not sure of the other three.

Mr. Sant. Neither am I; they rotate.

Mr. RYAN. Thank you very much for your appearance here today.

We appreciate your testimony.

I hope, if anything comes up which is of significance to this committee, that you will not hesitate to give us a holler. There is an interest here which continues; believe me.

Thank you very much. Mr. Sant. Thank you.

Mr. Ryan. This subcommittee is adjourned until 10 a.m. tomorrow. [Submissions to additional subcommittee questions follow:]

QUESTIONS FOR ROGER SANT, FORMER ASSISTANT ADMINISTRATOR, FEDERAL ENERGY ADMINISTRATION

Question 1. As someone who has worked closely with the Federal Government's energy conservation effort, do you believe the FEA's energy conservation program is effective?

Answer. Per dollar expended, it is very effective.

Question 2. Do you believe the Federal agencies are doing all they can under present authorities to decrease energy demand and to increase the efficient use of energy?

Answer. No.

Question 3. Do you believe that the FEA has been more concerned with increasing energy supply rather than reducing demand? Why?

Answer. Yes; because that's where the constituency is.

Question 4. Do you believe it is possible to make effective programs in energy conservation without some belt-tightening by the citizens and businesses of the country?

Answer. Yes. It's a matter of increasing efficiencies. Question 5. Did you help organize Project Conserve?

Answer. Yes.

Question 5a, In your opinion, is Project Conserve an effective program?

Answer 5a. Yes, but its only funded in Massachusetts.

Question 5b. Are we actually making headway in changing attitudes and behavior in the home by providing each homeowner with customized information about his home?

Answer 5b. The Mass. project should be watched very closely. It's the only State where we have really tried to get information out to all homeowners.

Question 6. What about the energy conservation seminars that have been held across the country for business executives. FEA claims that these have been effective in changing attitudes—do you agree?

Answer. They have not started yet. I believe they will be effective—at a very

low cost.

Question 7. What do you feel should be done under present authority to improve energy conservation in buildings that is not presently being done?

Answer. I answered that in my testimony.

Question 8. A recent report by the House Interior Appropriations Committee

on FEA's and ERDA's conservation program states:

"It is quite apparent . . . that FEA and ERDA are headed on a collision course as to who is best suited to market both the near- and long-term solutions being sought in the energy conservation area."

Do you agree with this statement?

Answer. No-but it would be best to combine the two.

Question 9. Are there other areas of FEA overlap with other agencies, such as National Bureau of Standards, that you are aware of? Could you discuss them briefly?

Answer. No-its not a big problem.

Question 10. FEA has given emphasis to conservation in the public schools. Would you comment on the effectiveness of the Public School Energy Conservation Service?

Answer. Where it's been done, its very effective, but there is only enough money to put one full person on the project.

QUESTIONS FOR JOHN P. EBERHARD, PRESIDENT, AIA RESEARCH CORP.

Question 1. Is AIA Research Corporation a part of the American Institute of Architects?

Answer. The AIA Research Corporation was established by the AIA in 1972 as a separate though related corporation.

Question 2. In your opinion, which of ERDA's energy conservation research projects has the most potential?

Answer. I don't think I have enough information to answer.

Question 3. Do you feel that the research that AIA does should differ from that done by ERDA?

Answer, Some of our research should be supported by ERDA.

Question 4. Do you think ERDA's priorities for energy conservation, in general, and energy conservation in buildings, in particular, are correctly placed? How should they be changed?

Answer. I indicated this in my written statement.

Question 5. Have you been able to identify areas of overlapping or duplicating responsibilities in the energy conservation programs of the various Federal agencies? What are they? Are there areas of disagreement on policy that are apparent?

Answer. Not enough information available. Seem to be differences.

Question 6. In your estimation, is there a need for a coordinated energy conservation plan or program to guide Federal agencies toward certain energy conservation objectives?

Answer. Yes; and Congress should develop one.

Question 7. Is ERDA's energy conservation program consistent with the AIA report entitled "A Nation of Energy Efficient Buildings by 1990"? Does ERDA concur with the findings in this report?

Answer. Only in a limited way. I don't think so.

Question 8. Do you think it is possible to achieve the AIA goals articulated in the AIA report?

Answer. Not in fact, but in theory it represents the 12 million barrels/day that could be saved if all buildings were redesigned and all new buildings were designed with energy in mind.

Question 9. ERDA, FEA, and the National Bureau of Standards are engaged in energy conservation research. Do you think it is necessary and appropriate for so many Federal agencies to be involved in energy conservation research? Does the involvement of so many Federal agencies confuse or retard the Federal energy conservation research effort in any way?

Answer. As long as there is a clear division of responsibility, it seems all right.

Depends again on their division of responsibility.

Question 10. On page 5 of your statement you state that "A different perception of the problem emerges when we recognize that buildings are intended to provide shelter for some human activity and that it is the comfort of the people engaged in such activity that produced a requirement for heating and cooling." In your view, are Americans eventually going to have to sacrifice some of the ideal conditions and comfort provided by air conditioners and heating units in order to reach a higher plane of energy efficiency in buildings or can improved use of materials and design replace the present technology we so religiously live by?

Answer. In my view, we may be required to modify our life styles to adjust to using less energy, this will not necessarily be negative. It will, however, depend very much on peoples perceptions of their own ability to adjustment versus a forced adjustment by government.

AUGUST 20, 1976.

Ms. EILEEN W. THEIM,

Chief Clerk, Conservation, Energy, and Natural Resources Subcommittee of the Committee on Government Operations, Rayburn House Office Building, Room B-371-B-C, Washington, D.C.

Dear Ms. Theim: With reference to your letter of August 4, I have gone over the testimony and have marked a few places where changes would be in order. I also am listing below answers to questions 1 through 13.

Question 1. Are you testifying today as a representative of the AIA or does

your testimony represent your personal views on energy conservation?

Answer. I am appearing in an individual capacity, expressing my views, However, many of these views were derived while serving as the Chairman of the AIA's Energy Steering Committee.

Question 2. Does the AIA endorse and concur with the findings and recommendations outlined in your two publications, "A Nation of Energy Efficient Buildings by 1990" and "Energy and the Built Environment: A gap in Current Strategies"?

Answer. Yes. In the case of both reports the AIA Board adopted them as official

AIA positions and policy.

Question 3. On what points made in your studies does AIA disagree?

Answer. None.

Question 4. It is my understanding that the thrust of the present Federal energy conservation effort is to increase the efficiency of energy utilization without reducing the standard of living many Americans currently enjoy. Do you believe that it is possible to make significant strides in energy conservation without some sacrifices on the part of the American public?

Answer. Yes, if you will refer to the report which I have entitled "Energy Conservation Research: A Key to Resolving the National Energy Dilemma," you will find some discussion on and estimates of the extensive amounts of energy

which can be saved without sacrificing freedom or quality.

Question 5. In your publication, "Energy and the Built Environment" you say that the potential for energy conservation in buildings over the next three to five years, when compared with the magnitude of the current energy problem and the enormous energy needs of the country, "looks too small to warrant a major thrust." But you go on to say that over the long-term energy conservation in buildings holds great promise. Would you please explain why you do not feel that energy conservation in buildings holds promise for the near-term?

Answer. I do feel energy conservation in buildings holds great near-term potential. My remarks were meant only to acknowledge that this strategy begins with a smaller base and extends it from year to year. I have emphasized my be-

lief that this form of conservation offers the best form of investment for the energy dollar which could be made, up to the point that the potential is fully

tapped. This is true even of the short term.

Question 6. In that same publication you estimate that the potential energy savings that could result from improving energy use in buildings would range from 25 to 50 percent in older buildings and from 50 to 80 percent in new construction. Could you please explain how you arrived at these rather impressive statistics?

Answer. At the time we made these estimates they were a compilation of studies which had been done at the time plus judgment of qualified personnel as to reasonable conservation potentials. Studies evolving since then have continued to show that these are relatively conservative estimates. Among the key studies which we feel sustain these estimates are:

ERDA's estimates for mid-term objectives are to decrease unit consumption in existing buildings and community systems by 30 percent and in new buildings by 50 percent. These estimates are based upon studies of various buildings and

conditions.

FEA, in a review of the building sector, estimates savings of 20 percent to 50 percent in present buildings depending upon the type of construction; in new buildings the estimated savings are 50 percent of the projected increase in overall energy used.

A study done for the Ford Foundation Energy Policy Project estimates savings

up to 40 percent in present buildings and 80 percent in new buildings.

GSA Energy Conservation Design Guidelines for Office Buildings shows estimates of 60 percent savings for better construction and design systems.

These studies in general refer only to savings which accrue from measures to reduce consumption. In our estimates we were also considering utilization of on-site generating capabilities from renewable resources such as solar. Though the potential of these on-site capabilities varies widely from region to region and by type of building, estimates range from 25 percent to 50 percent or more of total energy requirements which could be met in this way. We therefore continue to find that emerging studies show the conservative nature of our original estimates.

Question 7. Your study indicated that these impressive savings can be attained "within existing technology" and that the only stumbling blocks to their implementation are either economic, political or attitudinal. Could one conclude from this that the major Federal emphasis should focus on eliminating the stumbling blocks rather than increased emphasis on energy conservation research and

development?

Answer. I am not so sure that you can so easily isolate the two types of expenditure. The various non-technical barriers are no less a legitimate domain of research efforts than are more efficient forms of solar collectors. I do believe, however, that relatively more attention should be devoted to getting on with realizing our present technological capabilities. Again, you will find some extensive discussion about the inadequacies of our current demonstration programs in the final chapter of the report; "Energy Conservation Research: A Key to Resolving the National Energy Dilemma.'

Question 8. What do you think the Federal Government should be doing to reduce or eliminate the economic, political or social barriers to improved energy

conservation in buildings?

Answer. This question cannot be answered simply. The reports which I have brought together outline my thoughts on what should be done. However, in summary form I think the emphasis should be placed on incentives, on developing sound institutional mechanisms which can provide a reliable logistic maintenance and support system for large scale area wide intensive uses of conservation technologies, and more adequate demonstration and training activities. Specific recommended legislative strategies are contained in the documents which I have brought with me and which I suggest be entered into your record.

Question 9. Do you believe that television spots, bumper stickers, and educational literature, similar to what FEA has been employing, are effective tools to

educate the public on energy conservation?

Answer. They are probably effective insofar as certain types of conservation are concerned. What I would basically term behavioral conservation. They might make someone drive more slowly or wear sweaters in a lower heated house. They might even stimulate some caulking and other easy and somewhat obvious actions. They are not, however, an adequate conservation strategy by any stretch of the imagination.

Question 10. I have become very interested in the concept of multiple use buildings. As an architect that has spent a considerable amount of time studying the subject of energy conservation, do you believe that greater emphasis in the public and private sector on multiple use buildings holds much promise for improving energy conservation in buildings? What are some of the barriers that

would prevent wide utilization of multiple use buildings?

Answer. There is no question in my mind that multiple-use buildings would be an important part of any national energy conservation plan. The concept of constructing in a single building—levels of parking space, levels of merchandising space, levels of office space, and levels of housing space—is a very sound use of land and could be important not only from the standpoint of cutting energy use in transportation but could be the source of considerable energy transfer from one type of usage to a second or third type. As an example, the lighting used in merchandising throws off a considerable amount of heat which could be used in other portions of a building. You could say the same thing of commercial office space.

City Planners for some little time have been trying to implement the idea of multiple-use buildings. There is no question as to the soundness of this concept, but there are barriers that must be overcome. For some years, we have encouraged our people to live in a suburb on the north side of the city and work in a business complex on the south side of the city, traveling sometimes many minutes,

or perhaps hours, to accomplish this.

One of the basic concepts behind multiple-use buildings is drawing the functions of people closer together—get them started living closer to where they work and where they play. Multiple-use buildings, I am sure, as well as multiple-use neighborhoods, is a concept that must be popularized if we are going to be fully successful in conserving energy for our Nation. The barrier, of course, that must be overcome is the suburban complex that we have built into our people.

Again, leadership is the key needed ingredient: sustained, integrated, imagi-

native, creative leadership.

Question 11. In your study, "A Nation of Energy Efficient Buildings by 1990," you criticize present Federal energy conservation policies by saying that:

"We are now investing vast quantities of increasingly scarce capital resources in strategies which have less potential, less certainty and longer-delay payoffs than the proposed alternative strategy emphasizing a national program for energy efficient buildings."

Could you please be specific as to which strategies have less potential and

why?

Answer. As that report emphasizes, the major energy investments then and now are supply oriented; that is, we are attempting to refill the energy pipelines with any of a variety of new centrally located sources but primarily coal, oil and nuclear. To the degree that we regard investments in energy efficient buildings as an alternate to supply, we can reduce the amounts of capital invested in the central generating plants. That capital has normally been injected into rate structures so as to be recouped over about a twenty-five to thirty year time period. Of course, some current proposals advocate reducing this pay-back period through increased rates. In addition, we are plowing millions of dollars into advanced research for advancing these technologies; research which is needed but which must now be regarded as an uncertain pay-off. To the degree that dollars will buy the energy efficiency we estimate, they represent immediate returns, they are certain returns, and they are likely to pay themselves out, without artificially raising rate or price structures to force a shorter pay out, within well under twenty years. In many instances, in less than ten years. Moreover, once these investments are made, they continue to pay for themselves over I would refer you to my discussion in a testimony pointing out the economic highlights and emphasizing that we are converting consumption expenditures which have no end into investment expenditures which generate savings for the average family year after year.

Question 12. Have you discussed your studies with officials at GSA, FEA and

ERDA? What was their reaction?

Answer. Yes, we have held a variety of discussions and provided many copies of our reports to such officials. Their reaction has been generally favorable, though we have had no one grasp the aggressive and innovation role of active leadership to begin A National Program of Energy Efficient Buildings by 1990. I see little reason to believe that this condition will change unless some leader emerges within the federal structure to make it happen.

Question 13. How long do you think it would take us to reach your goal of a 7 percent saving each year in energy if a high-priority effort were made to make

buildings more energy efficient?

Answer. That rate of 7 percent per year is the fifteen year concept of converting the nations buildings, assuming that we could do so at a fairly even rate. It would mean that we would have the job done, if we converted 7 percent per year, sometime within the fifteenth year. I think we could and should get started on this now. It would probably take a year to "gear up" and after that we should be underway. I should emphasize, however, that this assumes the program would be given top priority and aggressive leadership.

Sincerely yours,

LEO A. DALY, FAIA.

FEDERAL ENERGY ADMINISTRATION, Washington, D.C., August 31, 1976.

Hon. LEO J. RYAN,

Chairman, Subcommittee on Conservation, Energy, and Natural Resources, Committee on Government Operations, House of Representatives, Washington,

DEAR MR. CHAIRMAN: This is in response to the August 4 letter to Robert Hemphill of my staff from Eileen W. Theim, Chief Clerk of the Subcommittee on Conservation, Energy, and Natural Resources which transmitted the transcript of the subcommittee's recent hearings on energy conservation in buildings and a series of follow-up questions on the subject. Enclosed is the corrected transcript of Mr. Hemphill's testimony and our response to the questions raised by Ms. Theim.

Although I was unable to testify during the hearings, I am informed that Mr. Hemphill adequately represented our office in my absence. I would like to convey, again, my appreciation for the opportunity to describe our activities to the subcommittee. I look forward to working with you in the future on this subject. In the meantime, if you have any further questions on this or other topics related to energy conservation, do not hesitate to call.

Sincerely,

SAMUEL J. TUTHILL, Assistant Administrator, Energy Conservation and Environment.

Enclosures.

GENERAL QUESTIONS ON FEDERAL ENERGY CONSERVATION PROGRAM

Question 1. What is FEA's present strategy to decrease the demand for energy in the country?

Answer. The Office of Energy Conservation and Environment (C&E) was established to: (1) develop and oversee the implementation of equitable voluntary and mandatory programs to promote the efficient use of energy; and (2) ensure environmental concerns are balanced with national energy goals.

In fiscal year 1976 we shifted our efforts from identifying those areas that hold the greatest potential for energy savings to the formulation and implementation of programs that are directed toward the actual achievement of these savings. Several major programs were established or expanded in order to encourage the widespread adoption of conservation measures. The criterion of cost-effectiveness was applied to all our conservation and environmental efforts. Specifically, in the conservation area, only those actions that would save energy at a cost lower than the cost of available energy supplies were considered relevant opportunities.

Our energy conservation programs were designed to reduce energy consumption to the maximum extent possible with existing technology, while also minimizing

the cost to the Government.

To accomplish these goals, we initiated a wide range of programs to encourage and assist individuals, businesses, and public institutions to conserve. Because conservation is in the economic self-interest of virtually all energy users, our programs have emphasized the provision of detailed information on the costs and savings of proven conservation measures rather than arbitrary controls on energy use. These efforts range from public service advertising to workshops and seminars for representatives of commercial and industrial firms.

To support our voluntary programs, FEA has made several specific legislative proposals. These include the Weatherization Assistance Act, and Building Energy Conservation Standards Act, which were incorporated into the recently passed Energy Conservation and Production Act (P.L. 94–385).

Until the passage of the Energy Policy and Conservation Act (P.L. 94-163, EPCA), all of our conservation efforts were founded upon the general authority provided under the Federal Energy Administration Act of 1974 (P.L. 93-275,

Sec. 5).

EPCA provided FEA with several new authorities, and we are now directing most of our resources toward those activities specifically mandated by EPCA. We are convinced that EPCA encompasses many of the areas where there exists a major potential for energy savings in the next 5 to 10 years. The Energy Conservation and Production Act of 1976 provides for additional programs in the areas of energy conservation standards for new buildings, and weatherization assistance for low income persons, as well as a program at the state level to provide building owners with reliable energy conservation information, and a program to demonstrate incentives to encourage homeowners to make energy conservation related investments in home improvements.

Both the EPCA and the Energy Conservation and Production Act (P.L. 94-385) also provided for the gradual decontrol of domestic oil prices. By enabling prices to rise to market levels, there will be increased incentives for developing additional supplies as well as using the available energy supplies more efficiently. These Acts, in combination with the decontrol of new natural gas supplies, and the implementation of the conservation programs cited above, can ensure that the Nation's vulnerability to arbitrary future interruptions in the supply of imported

oil will be minimized and eventually eliminated.

Question 2. Is it fair to say that the FEA conservation program is concentrating more on the increased efficiency of energy use rather than reducing

demand? Why?

Answer. Energy Conservation can be divided into two broad categories: (1) measures that require some sacrifice in comfort or convenience by energy-users, such as reducing thermostats to 68 degrees, purchasing a smaller car or eliminating unnecessary lighting; and (2) investments in more energy efficient equipment, buildings or systems, such as installing ceiling insulation in a home or heat

recovery equipment on an industrial process.

Both categories of conservation actions have associated with them different kinds of costs and benefits. For example, reducing thermostats during the winter months may result in some loss of comfort, but it also results in significant dollar savings by reducing utility costs. On the other hand, installing ceiling insulation reduces utility costs by improving the thermal efficiency of the home, but it requires some investment by the homeowner, whereas lowering the thermostat does not. Clearly, there are economic and other tradeoffs which must be weighed by the energy-user before he or she adopts a conservation measure. For a particular energy-user, buying a smaller car may be a much more attractive way of saving energy than improving the thermal efficiency of his home.

FEA has programs which involve conservation actions falling into each of the two categories, although the emphasis is on those types of conservation actions that would not require significant change in the kinds of lifestyles to which

most people are accustomed.

Question 3. Which Agency-FEA or ERDA-is responsible for marketing near-

and long-term solutions in the energy conservation area?

Answer, Both Agencies have been given broad congressional mandates to establish programs to transfer information on energy conservation to end-users. FEA, however, has the broad responsibility to conduct programs to disseminate information (under EPCA) on commercially available energy conserving technologies and practices. ERDA, on the other hand, has the broad responsibility to research, develop and demonstrate the commercial viability of new. more energy efficient technologies and methods. Furthermore, in their Memorandum of Understanding (MOU), both Agencies have agreed to undertake joint or coordinated, as appropriate and authorized by law, public information and education programs. This coordination will extend to programs of technology transfer and specialized education as well as general information transfer.

Question 4. It has been suggested that FEA and ERDA are on a "collision course" as far as their energy conservation programs are concerned. Is there overlap in FEA's responsibilities and authorities in the area of energy

conservation?

If so, what are they and what is being done to improve coordination?

Answer. All of our conservation programs have been closely coordinated with other Federal agencies, including the ERDA, the Department of Transportation, the Department of Commerce, and the Department of Housing and Urban Development, as well as others. This coordination takes many forms, including regular staff contacts, joint funding of projects of mutual interest and Memoranda of Understanding to formally set forth the responsibilities of the agencies involved. In addition, the Energy Resources Council serves as a mechanism to ensure that

Federal energy policy is coordinated at a high level.

One recurring concern regarding interagency coordination is that those conservation programs already underway within FEA appear to overlap to some extent with those planned or just beginning within ERDA. Clearly, both Agencies have been given broad Congressional mandates to establish conservation programs, including programs to transfer information on energy conservation to end-users. Consequently, legitimate questions have arisen concerning the respective roles of the two Agencies. However, with the enactment of EPCA and the further development of ERDA's conservation programs, we believe that these concerns have been largely resolved. FEA's responsibilities include the implementation of the programs established by the EPCA, as well as the broad responsibility to conduct programs to disseminate information on commercially available energy conserving technologies and practices. ERDA, on the other hand, has the broad responsibility to research, develop and demonstrate the commercial viability of new, more energy efficient, technologies and methods.

The bulk of the potential for energy savings within the next 10 years can be achieved through the more widespread adoption of conservation technologies and practices that are commercially available—that is, their effectiveness has already been demonstrated and, if they are products, they can be readily purchased. As a result, we believe one of the principal emphases of the Federal effort should be on encouraging and assisting energy users, including individuals,

businessmen and institutions, to adopt these measures.

Of course, the Federal Government should also have a major role in the research, development and demonstration of new, more energy efficient, technologies and ERDA will take the lead in this area. Furthermore, we agree that the Agency sponsoring the development of a new technology should have the major role in formulating the Federal efforts required to obtain widespread commercial application of that technology.

Because there are likely to be many projects where the involvement of both Agencies would be desirable or where the respective roles of each Agency are not immediately apparent, FEA and ERDA now have a MOU which will establish a formal mechanism to ensure that duplication of effort is minimized.

Question 5. Are there duplicative efforts that continue to exist that were not

addressed in the memorandum? If so, what are they?

Answer, No. The language of the MOU between FEA and ERDA is quite broad. In it, it is agreed that the "two Agencies will work together and in a mutually supporting way in the formulation and execution of Federal strategies, and to effect energy conservation. . . FEA will be recognized as having primary responsibility with respect to all matters of pricing, allocation, end-use, and general industry regulation. except where ERDA has statutory responsibility in the nuclear area. FEA will also be the primary Agency in developing a coordinated National policy combining incentives to increase production and the efficiency of energy use. ERDA will be recognized as having primary responsibility with respect to matters involving energy research and develop-

ment of new technology."

The MOU also sets up a Steering Group to provide for maximum coordination of all new policy actions and technical initiatives to ensure that programs are compatible to the greatest possible extent. This group will meet as necessary, but at least quarterly. The MOU also agrees that there will be broad sharing of information and program results as well as coordination of public information

and education programs.

Seven working committees have been set up to iron out any overlaps or duplicative efforts that exist and to ensure that such duplicative efforts do not occur in the future. These committees are composed of members from both ERDA and FEA and meet regularly. They cover the following areas: (1) solar energy. (2) buildings conservation, (3) transportation energy conservation, (4) industrial energy conservation, (5) electric utilities, (6) regional cooperation, and (7) energy information and data base.

Question 6. We hear a lot about the declining energy growth rate in this country—apparently it has been reduced from 3.8 percent annually in 1973 to 2.8 percent in 1975. Is the energy growth rate expected to increase or decrease in 1976?

Answer. The implication in the question that the energy growth rate increased 2.8 percent in 1975 is in error. Total energy consumption in 1975 was 2.6 percent below 1974 consumption levels. Two factors contributing to this decline were (1) the adverse economic conditions that prevailed in 1975 and (2) the response of businesses and consumers to higher energy prices. In 1975, the major component of the decline in energy consumption was the industrial sector of the economy. Energy consumption in 1975 was down almost 9 percent from 1974 levels in this sector, However, in the first quarter of 1976, consumption in this sector increased 1.1 percent over the consumption in the first quarter of 1975. This contributed to a 1.4 percent rise in total consumption for the first 4 months of 1976 over the same period in 1975. If this trend continues, energy consumption in 1976 will be higher than in 1975.

Question 7. It is my understanding that FEA believes that a further reduction of the energy growth rate in the near-term can be accomplished only with some strong mandatory energy conservation standards, and even then, the growth rate cannot be reduced below 2.2 percent. Is this an accurate assessment of FEA's

position?

Answer. Higher energy prices should significantly cut energy demand growth during the next 10 years, reducing the growth rate to 2.8 percent from the his-

torical rate of 3.6 percent.

An active conservation program (as described in the 1976 National Energy Outlook) could further reduce energy demand by the equivalent of 3 million barrels per day, reducing the annual energy growth rate to 2.2 percent through 1985. Savings could be achieved in all the major sectors—residential, commercial, industrial and transportation—with actions to improve the energy efficiency of automobiles, homes and office buildings having the greatest impact over the next 10 years.

While conservation can reduce energy demand, it does not appear feasible to cv* the growth rate to zero or to obviate the need for expanding existing supplies

of energy.

Question 8. Has the Federal Government developed a coordinated energy conservation plan with definite goals which could guide Federal energy conservation efforts in this country?

Question 9. Why hasn't such a plan been developed?

Question 10. With so many agencies of the Federal Government involved in energy conservation, doesn't it make sense that their resources could be more efficiently employed if an energy conservation plan were developed?

Question 11. Which agency in the Federal Government should be responsible

for developing such a plan?

Question 12. Have there been any efforts made toward developing such a plan? Answer, Questions 8 through 12 deal with the development of a coordinated energy conservation plan for the Federal Government. The overall structure for such a plan is contained in the President's State of the Union Addresses for 1975 and 1976. The broad goals of this plan include:

1. To halt our growing dependence on imported oil during the next few critical

vears

2. To attain energy independence by 1985 by achieving invulnerability to disruptions caused by oil import embargoes. Specifically, to reduce imports to between 3 and 5 million barrels a day, with an accompanying ability to offset any future embargo with stored petroleum reserves and emergency standby measures.

3. To mobilize our technology and resources to supply a significant share of

the free world's energy needs beyond 1985.

The President's energy conservation programs include the following: (1) Federal energy management program, (2) conservation in buildings, (3) conservation in industry, (4) conservation in automobiles, (5) aircraft fuel conservation, (6) conservation R. & D., and (7) State energy conservation programs.

ERDA and FEA are the principal Agencies involved in energy conservation and elements of a National energy plan can be found in ERDA's "A National Plan for Energy Research, Development and Demonstration" and FEA's "National Energy Outlook." Another element of a national energy conservation program is the Federal Energy Management Program (FEMP) which directs all Federal agencies to continue a program of strong energy management in improving the efficiency of their buildings and operations.

While the development of a comprehensive energy conservation plan can and is being done in part by a number of different Federal agencies, the Energy Resources Council (ERC) is charged with the overall formulation and execution of major energy policy initiatives. Thus, ERC is responsible for the coordination and initiation of energy conservation planning efforts.

PROJECT CONSERVE

Question 1. It is my understanding that FEA is relying heavily on Project Conserve to reduce demand and improve energy efficiency in residential and commercial buildings across the country. How much has been spent on this project so far?

Answer:

Development and pilot testing of Project Conserve in Topeka, Kans., and Danbury, Conn	Amount \$155, 482
Project Conserve programs in cities of : Minneapolis/St Paul	
	21, 997
Louisville	38, 305
Indianapolis	56, 391
Total	
Modification of system to be ready to run in a high-volume State level	
program	58, 338
Commonwealth of Massachusetts	215, 000
State of New Mexico	67, 800
Maining lists	12, 900
Postage	138, 197
Frinting	184, 500
Technical assistance	75,000
Data processing	146 695
Advertising	120,000
Subtotal	1, 018, 360
Total	
Question 2. Project Conserve is based on a questionnaire which is by the homeowner, then returned to FEA where it is analyzed by a then returned to the homeowner. This questionnaire is designed to homeowner identify areas in his home where energy efficiency can be How many homeowners have been reached by this program so far? Answer:	computer,
	Tomeowners
Danbury, Conn	2, 325
Topeka, Kans	2, 323
Total	4, 446
Minneapolis/St. Paul	425, 000
Louisville, Ky	204 000
Indianapolis, Ind	400, 000
Total	1, 029, 000
Massachusetts	004 000
New Mexico	924, 000 256, 213
	200, 213
Total	1, 180, 213

Question 2. How much does this program cost per homeowner reached, and how much will it cost to process questionnaires from the estimated 40-million individual residences in the country.

2, 213, 659

Grand total____

Answer. Based on the five city pilot tests and the two State Project Conserve programs, the cost per homeowner reached was approximately 59 cents.

Costs for processing 40 million Project Conserve questionnaires @ 85 cents

each equals \$34,000,000.

Question 3. Have there been any measurable results from Project Conserve that you can report?

Answer. The attached copy of the Project Conserve Final Report outlines the results of the pilot tests in the cities of Danbury and Topeka.

Question 3a. When will an evaluation of the effectiveness of Project Conserve be available?

Answer. It is anticipated that an evaluation will be made sometime in 1977, after completion of the Project Conserve programs in Massachusetts and New Mexico.

Question 4. Do you have a similar program for commercial establishments? Answer. No, we do not have a similar program for commercial buildings. However, in September 1974, through FEA funding, Education Facilities Laboratories. Inc. developed what is now known as PSECS (Public Schools Energy Conservation Services). PSECS is a computer based technical service designed to help and encourage school districts to improve their facilities and equipment. The FEA has agreed to provide limited funding for test marketing of the elementary school package in selected school districts in order to refine the process, determine the costs involved in operating PSECS, and further develop procedures that can be used in full scale marketing activities.

Question 5. FEA has claimed that about 80 percent of building representatives who participated in voluntary energy conservation programs for business took some action, resulting in an average reduction in energy use of more than 20 percent. Is this true? How do you know 80 percent took action and what basis do you have for reporting a 20 percent reduction in energy use in commercial establishments?

Answer. These estimates are based on reports from FEA Regional Offices which implemented the program, and established their individual target by which to measure success. These targets ranged from 50 percent to 95 percent. The basis for reporting a 20 percent reduction is the large number of applications received for awards which have had savings of over 30 percent of electrical consumption. Each region planned on contacting the larger consumers in accordance with FEA guidelines. A statistically valid evaluation of the success of this program has not been completed. Interim reports from our regions filed in January 1976 indicated adequate progress in meeting regional goals. On this basis, we have stated that 80 percent of those large electricity users contacted by the regional offices would undertake conservation actions which would save an average of 20 percent. We are in the process of compiling case studies on conservation actions taken in these buildings.

Question 6. What percentage of the businesses across the country have participated in FEA's program?

Answer. FEA's program focused only on the larger businesses (those with 100 or more employees). Information from the regional offices indicates that approximately 70,000 firms were contacted by mail but they have had the staff resources to contact only less than 10 percent of them either by phone or in person. We estimate that there are over one million business establishments in the country.

Question 7. It is my understanding that FEA uses seminars to educate industrial and commercial representatives as to ways in which energy conservation retrofitting techniques can be employed. Are these seminars conducted by FEA employees or are they done under contract?

Answer. The design, development, and conduct of the seminars and workshops are being done under contract.

Question 7a. Why are these seminars contracted out?

Answer. There are several sound reasons for doing this work under contract. The professional staff needed to design, develop, test and implement an extensive series of workshops and conferences is not available within the Agency; either with respect to the numbers of people needed or the requisite areas and level of qualifications. A variety of specialized skills and backgrounds is required, including engineering, experience in management-level training, conference administration and logistics, technical writing/editing, and graphics design.

It is unlikely that the Agency could assemble the needed staff through hires, transfers or details within any reasonable time. Further, the requirement for such staff is limited to the few months of design and development and the ap-

proximately 1 year period of operations.

Rather than increase staff for a limited duration program, the clear alternative was to employ contractors who possessed the requisite staff, skills and backgrounds.

Question 8. How much has been spent on these seminars so far?

Answer. Only a small fraction of the \$3-million budget has been spent; to date, less than \$200,000. It should be noted that contracts were awarded in early July and that the program is still in the design phase. We have estimated that design, development, testing, and other preparatory activities will require approximately \$1,000,000, or less, with the balance of the \$3,000,000 dedicated to field operations and conduct of more than 600 conferences, workshops, and seminars.

ENERGY CONSERVATION STANDARDS FOR HOMES AND BUSINESSES

Question 1. Are you aware of the energy conservation standards for build-

ings that have been developed by the National Bureau of Standards?

Answer. Yes. In early 1974, the National Bureau of Standards published draft criteria for energy conservation in new buildings at the request of the National Conference of States on Building Codes and Standards (NCSBCS). This latter organization subsequently submitted these draft criteria to the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) for their revision. ASHRAE Standard 90-75 was completed in August 1975.

Question 2. What efforts are currently being made to gain acceptance of

these standards on the State and local level?

Answer, ASHRAE itself has undertaken a number of education seminars for their members on the content and use of ASHRAE Standard 90-75. Two major programs are underway at the Federal level to encourage States and local gov-

ernments to adopt these standards into their building codes,

First, under the Energy Policy and Conservation Act (EPCA) and regulations drafted subsequently, one condition the States must meet to receive a share of conservation program funds is the adoption of a mandatory thermal efficiency standard at least as effective as ASHRAE Standard 90-75. FEA is currently holding 1-day seminars in each of the 10 FEA regions to introduce State officials to the energy standards currently available, and to help them to begin the planning required for effective implementation of these standards.

Second, ERDA has initiated a contract with the NCSBCS to develop model training materials for use in training State and local code officials on the adoption and implementation of energy efficiency standards. Their standards pro-

gram also includes a number of other activities.

Question 3. What are the major barriers to implementation of energy conservation standards at the local level? Does FEA have any idea as to how

these barriers might be approached and overcome?

Answer. In many jurisdictions the most important barrier to the effective implementation of energy efficiency building codes is simply resistance to change on the part of various code officials. This is particularly true of performancebased codes which may require entirely new methods of compliance certification.

More specifically, we see the primary barrier as one of information and education. Building code officials are generally untrained in the analysis of energy use in buildings. Concepts of life-cycle costing, or of heatflow analysis are foreign to them. The ASHRAE Standard 90, for example, requires that the overall thermal transmittance of a wall section (including windows and doors) of an office building over three stories in a 6000 degree day climate must be less than 0.33. Interpretation of this requirement requires an understanding of heat flows and the properties of various materials. Although the initial certification of compliance with this standard will probably be done by the building engineer, the code official must be familiar with such analysis in order to conduct whatever verification is required. Though relatively simple ways of certifying compliance are being developed, a substantial retraining of code officials is required before they can be effective in implementing an energy conservation code

This retraining can be accomplished through existing private and public organizations, such as ASHRAE, and the model code organizations, but substantial amounts of money are required to develop materials and to accomplish the training. Federal programs will accelerate this activity.

Question 4. It is my understanding that HUD is currently developing so-called "energy budget" performance standards. Does FEA have any responsibilities in

the development of these standards?

Answer. Legislation requiring the Secretary of HUD to develop such standards for both residential and commercial buildings within 3 years was included as Title III of the FEA Extension Act (P.L. 94-385), signed by the President on August 14. The Secretary is required to consult with FEA in the development of these standards. In general, FEA will concentrate on the policy issues surrounding the development of standards, such as economic criteria, the effects on employment and on total energy demand, etc. The specifics of each agency's roles have yet to be defined. A mechanism to accomplish this definition has been established under the auspices of the Energy Resources Council.

Question 5. What is FEA's role in the Appliance Labeling program?

Answer. FEA is responsible for the development of test procedures for consumer products which reflect energy use, energy efficiency, or estimated annual operating cost. In addition, FEA is responsible for providing manufacturers information respecting representative average unit costs of energy for purposes of calculating estimated annual operating cost.

Question 5a. What is the status of that program?

Answer, FEA has published a proposed test procedure for room air conditioners. Proposed test procedures for dishwashers, clothes dryers, water heaters, TV receivers, refrigerators, refrigerator-freezers, and freezers are in the final stages of internal review and should be published shortly.

Question 5b. What are the energy conservation targets for this program and

when can we expect to see some results?

Answer. The following energy efficiency improvement target ranges for 1980 have been proposed:

	Percent
Refrigerators, refrigerator-freezers	43–50
Freezers	
Dishwashers	
Clothes dryers;	
Gas	14-20
Electric	6–14
Water heaters:	
Non-electric	33-35
Electric	10-12
Room air-conditioners	28-40
Home heating equipment	(1)
Televisions:	
Monochrome	92-94
Color	
Kitchen ranges and ovens:	
Electric	8-20
Non-electric	
Clothes washers	BERRETERE STREET

¹ Range not established.

Another round of public hearings and comments is planned for September before final targets are set. It may be approximately 2 years before a large number of energy efficient products are available from manufacturers. Planning and retooling will delay the widespread introduction of new products which operate more efficiently.

ENERGY CONSERVATION IN FEDERAL BUILDINGS

Question 1. What are the Federal Energy Administration's responsibilities in

reducing energy usage in Federal buildings?

Answer. FEA is responsible for establishing general policies for energy conservation efforts within the Federal Government. The departments and agencies are responsible for implementing measures to reduce energy use. Within the Office of Energy Conservation and Environment, there is a small staff responsible for coordinating and reporting on the Federal Energy Management Program (FEMP). This program came into being as a result of the President's energy statement of June 29, 1973, which directed Federal departments and agencies to achieve a 7 percent reduction in anticipated fuel use during FY 1974. The eleven cabinet level departments and five independent agencies, accounting for 97 percent of the total personnel, vehicles, buildings and facilities, were chosen as the initial active participants, and eleven other agencies were subsequently added. Strategies were developed and implemented to reduce energy use in all areas, concentrating on vehicle, ship and aircraft operations (which account for about 50 percent of the total), and buildings and facilities (which account for most of the remainder). FEA with assistance from GSA, established general guidelines which participating agencies used to develop actions within their organizations.

The results of the Agencies' efforts were significant; energy use in the Federal Government has dropped about 24 percent, a savings amounting to over 250,000 barrels per day oil equivalent and avoiding costs aggregating over \$1.6 billion through FY 1975.

With regard specifically to buildings and facilities, the policies formulated by FEA include reduced lighting levels, thermostat adjustment, reduced operating hours, and daytime cleaning. Agency implementation has reduced energy use in their buildings and facilities by 15.2 percent. The tabulation on the following page

provides additional details.

In addition, FEA has been given the responsibility for developing the 10-year plan for energy conservation in Federal buildings required by the Energy Policy and Conservation Act (EPCA). The items explicitly required include: (1) mandatory lighting efficiency standards; (2) mandatory thermal efficiency standards; and insulation requirements, (3) restrictions on hours of operation; (4) thermostat controls; and (5) other conditions of operation. As required by EPCA, the plan being developed will address replacement or retrofitting of both owned or leased buildings. The plan is to be submitted to the President; and FEA expects to coordinate the implementing activities of the departments and agencies.

Department/agency	Number of buildings 1	Thousands of square feet 2	Fiscal year 1973 baseline	Fiscal year 1975 use 3	Savings 1	Percentage reduction
Agriculture	18,812	28, 735	5,699,8	6, 158. 8	3 454.0	3 8, 0
	1,032	3, 874	2,853,8	2, 365. 6	488.2	17, 1
	309,612	1, 818, 371	552,717.6	478, 347. 1	74,370.5	13, 5
Administration Environmental Protection Agency, General Services Administration Health, Education, and Welfare, Interior Justice Labor National Aeronautics and Space Ad-	6, 221	79, 895	97, 761, 8	81, 289, 4	16, 472. 4	16.9
	84	703	457, 8	424, 3	33. 5	7.3
	2, 988	190, 935	61, 004, 6	44, 414, 5	16, 590. 1	27.2
	2, 308	27, 771	7, 503, 6	6, 574, 8	928, 8	12.4
	34, 621	56, 211	13, 711, 8	11, 033, 3	2, 678, 5	19.5
	1, 788	13, 511	5, 053, 4	4, 674, 3	379. 1	7.5
	1, 670	8, 464	1, 761, 1	1, 398, 6	362. 5	20.6
ministration Postal Service I ransportation Treasury Veterans' Administration Other	2,432	31, 500	35, 550, 1	25, 455, 1	10, 095, 0	28. 4
	2,800	67, 713	52, 653, 1	44, 275, 1	8, 378, 0	15. 9
	11,078	30, 421	18, 371, 7	15, 674, 6	2, 697, 1	14. 7
	71	2, 982	2, 333, 2	1, 862, 7	470, 5	20. 2
	5,076	109, 871	39, 921, 8	37, 243, 2	2, 678, 6	6. 7
	742	5, 927	1, 988, 6	1, 610, 6	373, 0	18. 6
Total	401, 335	2, 476, 884	889, 343. 8	762, 802. 0	136, 541. 8	15, 2

¹ In U.S., as of June 30, 1974, 2 Btu×104.

1 Increase.

Question 2. The Energy Policy and Conservation Act of 1975 requires FEA to set up a 10-year program to retrofit existing Federal buildings for energy conservation purposes. What is the status of this program and its targets year to year? Can we accomplish the retrofitting of these buildings sooner than 10 years?

Answer. FEA has been given responsibility only for development of the 10year retrofit plan; implementing authority was retained by the President. However, even within this limitation, there are a number of issues to be resolved and

procedural details to be worked out before a plan can be delineated.

Because retrofit is a capital investment, money will be required to carry out retrofit projects identified through the planning process. There are only two ways of obtaining necessary funds; either dollars must be reprogrammed from existing budgets or additional amounts will have to be made available through the budget process. In either case, retrofit options must necessarily and properly compete with other requirements, Therefore, the basic budget guidance provided by OMB (now in preparation) will play a critical role in convincing agencies that the planning effort is worthwhile. By the same token, the availability of funds determines the speed with which the plan can be accomplished.

If it is determined by the Administration that the effort warrants priority considerations, and if Congress concurs and provides the necessary appropriations to the agencies to carry out the retrofit projects, then it is certainly pos-

sible to accomplish the retrofit program in less than 10 years.

The overall procedure for developing the plan is fairly clear at this point. FEA will provide guidelines and formats to the agencies, the agencies will develop

their individual plans appropriate to the buildings they own or control and submit them to FEA, FEA will integrate these into an overall plan for the Federal Government and submit it to the President. A handbook has been developed to assist agencies in identifying retrofit options at the facility level without expensive architectural and engineering surveys. The handbook also provides for standardized presentation of the cost and payback factors to facilitate cost-effectiveness evaluations both at the agency level and at FEA. It is currently being tested to ensure it is technically accurate and practically useful. When issued to the agencies, of course, the handbook will have to be consistent with the budget guidance promulgated by OMB in order to assure consistency between the planning and budget process. It is expected that the plan will be ready for submission to the President early in 1977. Year by year targets for retrofit actions to be accomplished will be one of the elements of the plan.

Question 3. What specifically is being done under the Federal Energy Management Program to improve energy conservation in Federal buildings?

Answer. As noted in response to question 1, FEA provides policy guidance and coordinates agency activities through the Federal Energy Management Program (FEMP). The simple, easily implemented actions identified at the outset will continue to be emphasized, and a series of visits to Federal installations have been carried out to emphasize the importance of energy conservation and verify the extent of implementation at the facility level. (A copy of the FY 75 Site Visit Report is appended.) Pursuant to a Presidential directive, FEA and GSA began planning additional actions to further reduce energy use in FY 75. The major actions identified to improve the energy efficiency of Federal buildings were closely parallel to the provisions of the Energy Policy and Conservation Act. Specifically, FEMP is:

Developing energy efficiency standards for new Federal buildings (discussed

in detail in response to request 6).

Developing guidelines and planning for implementation of a Federal retrofit

program (discussed at length in response to question 2).

Studying the factors impacting on building hours of operation. From the standpoint of buildings operation alone, it is obvious that restricting hours to a minimum produces energy savings. However, it appears that a moderate extension of operating hours to permit the use of staggered or flexible hours may result in a net energy benefit because of savings from increased transportation efficiency.

Data is being gathered to provide a basis for decision on this question.

Encouraging agency energy conservation actions through support of a number of demonstration projects. Essentially these fall into two groups: (1) architectural and engineering surveys of several Federal facilities; and (2) installation of energy management systems to control utility use within a facility. We believe these will concretely demonstrate the cost-effectiveness of energy conservation actions, thus providing a basis for planning and budgeting similar activities on a larger scale, especially in terms of convincing managers of the necessity for and wisdom of making moderate investments now to avoid large, continuing payouts for fuel in the future.

Question 4. Are there any Federal demonstration buildings funded by FEA? Are you involved in the design or planning of any Federal demonstration build-

ings being built and operated by the GSA?

Answer. FEA, with NBS, has provided some funds in connection with the demonstration building GSA is erecting in Manchester, N.H. However, our purpose was limited to providing instrumentation to collect performance data. We are following three GSA buildings (Manchester, Saginaw and Topeka) very closely as the experience gained will bear on the standards to be promulgated for new Federal buildings. Other than the above, FEA is not involved in the design or planning of Federal demonstration buildings being built or operated by GSA.

Question 5. What are the specific goals and objectives of the Federal Energy

Management Program?

Answer. The overall objective of the Federal Energy Management Program (FEMP) is to increase the energy efficiency of Federal facilities and operations. The primary reason, of course, is that the Federal Government uses a large amount of energy (about 2.4 percent of the total for the Nation in fiscal year 1975). No national policy on energy conservation or increased energy efficiency would be credible in the absence of an active effort by the Federal Government to implement the measures it is urging others to adopt. An important corollary is the opportunity to demonstrate effective measures in the Federal Government which can then be adopted by others. In support of the overall objective, con-

sideration is now being given to adopting a specific goal for fiscal year 1977 for the Federal Government of using no more energy than was used in fiscal year 1975.

Beyond the general objective and goal, FEMP has identified and is involved in a number of areas of high potential for saving energy. Some of the major specific aims are:

Achieve greater energy efficiency in existing buildings through cost-effective retrofit projects (e.g., adding insulation, replacing lighting systems with more efficient types, caulking, etc.);

Demonstrate and install energy management systems which monitor and control energy use in buildings;

Build new Federal buildings to be as energy efficient as possible given the current state of the art in design and technology;

Emphasize energy conservation through existing training courses for Federal employees;

Increase Federal employees' awareness of the dimensions of the energy problem and motivate them to individually contribute to its solution;

Foster greater utilization of vanpooling and carpooling which are very energy efficient modes of commuter transportation;

Demonstrate driver training techniques that have the potential of improving fuel efficiency by as much as 20 percent;

Purchase replacement vehicles for the Federal fleet which will travel further on a gallon of gas (EPCA Section 510);

Focus management attention on the need to use energy resources wisely and provide guidelines so that energy is managed in a manner analogous to control of other resources; and

Provide information on the effectiveness of Federal actions to reduce energy use and provide a basis for improved performance.

Question 6. Is FEA involved in any way in the development of energy efficiency standards for Federal buildings? What is the status of the development of Federal building standards and when will they go into effect?

Answer. As part of its response to the requirements of the Energy Policy and Conservation Act, FEA is developing energy efficiency standards for new Federal buildings. In order to keep the tasks to a manageable size, a decision has been made to develop a standard first for new Federal office buildings, and extend coverage to other building types at a later date. The standard will be performance-oriented rather than prescriptive, and will include guidelines for architects and engineers on how to use the standard to optimize energy efficiency. Full use is being made of existing materials, such as the American Society of Heating. Refrigerating and Air-Conditioning Engineers (ASHRAE) standard 90–75 and GSA design guidelines. A draft is expected to be available by the end of 1976 for review by Government agencies and others. Among other reasons, such a review is necessary to ensure the Federal standard is compatible with standards being developed for private and commercial buildings.

Question 7. Are new Federal buildings currently on the drawing boards being equipped with more energy efficient systems?

Answer. Yes, largely as a result of agencies' own concern about rapidly escalating prices for all kinds of energy. For example, the Topeka Federal Office Building which is expected to use about 26,000 Btu's per square foot per year (Btu/Sq. Ft./Yr.). This compares favorably with GSA's current design target of 55,000 Btu/Sq. Ft./Yr., and the average current use of Federal buildings of about 300,000 Btu/Sq. Ft./Yr. (to put this latter figure in perspective, however, it must be noted that it includes many buildings operating beyond the 8-hour, 5-day schedule as well as some usage relating to work operations). Adoption of standards applying to Federal buildings will strengthen and extend this

[Whereupon, at 12:45 p.m., the subcommittee adjourned, to reconvene at 10 a.m., Wednesday, July 28, 1976.]

ENERGY CONSERVATION IN BUILDINGS

WEDNESDAY, JULY 28, 1976

House of Representatives,
Conservation, Energy,
and Natural Resources Subcommittee
of the Committee on Government Operations,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10:04 a.m., in room 2203, Rayburn House Office Building, Hon. Leo J. Ryan (chairman of the subcommittee) presiding.

Present: Representative Leo J. Ryan.

Also present: Full Committee Chairman Jack Brooks.

Staff present: Norman G. Cornish, staff director; Robert K. Lane, assistant for energy; Ronald J. Tipton, assistant for environment; Eileen W. Theim, chief clerk; and Stephen M. Daniels, minority professional staff, Committee on Government Operations.

Mr. RYAN. The subcommittee will come to order briefly, and then we will recess for a few minutes. We are beginning at 10 this morning, as we normally do, but the House has decided to also meet this morning, beginning at 10. So we are in a conflict to begin with.

The three bells, which you just heard at 10:04, are a call for a quorum—which is simply the House's way of taking the attendance.

It is something like being in school.

I have to go over and answer the quorum call. Upon my return, we will begin the actual hearing itself. I hope I can bring some committee members with me; but, in any case we will begin the hearing as soon as I return.

So, the hearing, having been called to order, is recessed for about 6

minutes.

A short recess was taken.

Mr. RYAN. The subcommittee will come to order.

Today, the Conservation, Energy, and Natural Resources Subcommittee continues its hearings on Federal energy conservation programs aimed at improving the energy efficiency of buildings. Frankly, I am disturbed by what I have heard so far. I am not willing to accept these minimal "band-aid" solutions and bureaucratic approaches to the problem. The approaches we take in the built environment must be radically changed.

We learned during our hearing yesterday that there is a wide disparity between what is achievable in energy conservation and what is actually being done by the Federal Government in this area. We must change the way we utilize energy, not only in the heating, cooling, and

lighting of buildings, but in their concept and design as well.

I am as concerned as anyone about saving energy by having people travel to work by an elevator commute, rather than the 20-mile commute that I make. I would just as soon be able to come to work by walking as to come by driving 20 miles by automobile. That would not only save the cost of gasoline every day, but would also save the energy price of building the automobile.

That concept is somewhat recognized now; but too often, in the approach that is used by the Federal Government, not enough interest is shown in the longer range, rather than the shorter range, solutions.

We do need to lower the lighting; we do need to turn down or turn up the heat; we do need to develop thermal barriers that are more efficient. But this building itself, as far as I am concerned, continues to be a monument to the past. It is a dinosaur. This ceiling is too high. There is no need for the ceiling to be this high. It is a tradition; it is a custom. It comes from a time when, there being no other way to cool a building, people put in high ceilings because there were plenty of materials. The heat rose to the ceiling and produced more coolness down below. The mission-style of architecture which is so popular in California is the same kind of thing.

Today, we have a means by which we can build lower ceilings. We have air-conditioning. But we have air-conditioning, and we still have

high ceilings. It is a kind of classic design from the past.

And I think the Federal Government needs to lead in innovation and design in the construction of its buildings. I realize that ERDA is not necessarily as much up front in that as is GSA, for example. But I do think ERDA is in a position of leadership from which influence can be exerted.

It is our intention to make sure that the money appropriated for energy conservation is used to further that purpose of producing those results—both short range and long range. We do not have the function of the Appropriations Committee, before which ERDA also appears. But the line between oversight and appropriations on an annual basis is a distinction of kind, I think. We, more than does the Appropriations Committee, have the privilege to look further ahead.

The Appropriations Committee's job is to see if this budget fits these plans and fits within the particular needs of this year. Oversight committees can look further ahead and ask larger questions with larger

implications, and ask "Why not?" And I think we should.

Yesterday, Mr. Leo A. Daly, an architect who has devoted considerable time to the study of energy conservation problems in this country, made two important points which I believe deserve review this morning. He said that this Nation will pay dearly if we continue to delay launching a high priority national action program to achieve a nation of energy-efficient buildings within 15 years. Second, he said that if we continue on our present course, we are likely to delay indefinitely, and may even miss entirely, the realization of most of this potential.

As the oversight committee charged with the review of Federal energy programs, we do not intend to stand by and watch a blundering system rob the American people of potential savings of millions of dollars in natural resources and energy costs simply because it cannot get a coordinated program together. This is a matter of the topmost priority for this subcommittee. And these are only the first of

several opportunities that Federal agencies will have to report on their

Today we will hear from two agencies that have very important roles

in energy conservation-ERDA and the GSA.

ERDA has developed a widely-publicized energy conservation plan and, according to the literature that it has circulated around town, plans to treat energy conservation research and development on an equal basis with other energy sources. We will see if this is the case.

On the other, the General Services Administration is responsible for reducing energy consumption in Federal buildings across the country. Actually, I think it is a little broader than that. GSA should be interested in reducing energy in the larger sense, as well as the smaller sense. But we are particularly concerned because we want the Federal Establishment to set an example for the rest of the country. And after hearing from FEA yesterday, I must say that I have serious doubts as to whether this is being done well enough.

ERDA has a budget of some size. And there are varied pressures on ERDA to look into this and to look into that and to do this and to do that. So I realize the responsibilities you have in setting pri-

orities is probably one of the most difficult jobs you have.

I would like to begin by welcoming you here and by asking you to make your own comments. But I would also like you to comment on how you set your budget priorities; and, to discuss the concepts you have, which you are looking into, that relate to setting the example for other agencies in the country and for giving them the information that will enable them to construct areas of living that fit the new priorities which we have to have in going into the 21st century.

With that, we will begin with the testimony of Mr. Jack Eckerd,

the Administrator of General Services.

STATEMENT OF JACK ECKERD, ADMINISTRATOR, GENERAL SERV-ICES ADMINISTRATION; ACCOMPANIED BY TOM PEYTON, DEP-UTY COMMISSIONER, PUBLIC BUILDING SERVICES; AND RAY WHITLEY, CHIEF, ENVIRONMENTAL AND ENERGY BRANCH

Mr. Eckerd. Thank you, Mr. Chairman. I have brought with me Tom Peyton, who is our Deputy Commissioner of Public Building Services, and Ray Whitley, who is involved with our energy program. I do thank you, Mr. Chairman. I am very pleased to have this op-

portunity to discuss important policies and programs which GSA has developed to conserve energy.

I have provided a detailed statement, but to save your time I should like to submit it for the record and summarize the highlights. Mr. RYAN. Your statement will be accepted for the record.

Mr. Eckerd. GSA fully supports energy efficiency and conservation which will contribute to a successful energy program. We realize that a significant portion of this Nation's energy savings can be achieved through conservation in both public and private buildings.

GSA is responsible for 10,000 buildings, with a nationwide inventory of 250 million square feet of space. Now 62 percent of this 250 million square feet of space is owned by the Government, and the remainder is leased. In addition, GSA currently has 49 new construction or major alteration projects either being designed or already under construction.

Our energy conservation program covers four major areas. First is the design of all new buildings so that they will be highly energy efficient. Next is the operation of our large inventory of existing buildings to reduce energy usage. A third area of concern is the retrofitting of existing buildings to make them more energy efficient. And fourth is the use of solar energy, as it develops, to provide building heating, cooling, and hot water.

GSA's interest in energy conservation is not a new thing. In 1972, well before the oil embargo, we cosponsored, with the National Bureau of Standards, a roundtable on energy conservation where informed representatives of both the public and the private sector explored the possibility of designing buildings so they could be operated with re-

duced energy usage.

One outgrowth of this energy roundtable was GSA's energy conservation demonstration building. This building will be completed on line and occupied this fall in Manchester, N.H. It was designed with two purposes in mind: We wanted a building which could be operated with the consumption of a minimum amount of energy; and at the same time, we wanted to develop energy conservation design guidelines which could be used to make all future Federal buildings highly energy efficient. In short, we set out to initiate a new generation of buildings which would operate with 40 to 50 percent less energy than the typical modern building of comparable size, located in similar climate zones.

We will have a living laboratory here for the real world testing of

energy conservations features and systems.

With the financial support from the Federal Energy Administration, the Energy Research and Development Administration, and the National Bureau of Standards, the Manchester Federal Building is being fully instrumented so that we can get a complete performance evaluation when it is occupied and operational. The National Bureau of Standards, in cooperation with GSA, will make the performance evaluation. And successful features and systems will be widely publicized to encourage use by others.

Full details about the energy conservation features of this building

are being submitted for the record.

The Saginaw, Michigan Federal Building, also to be occupied later this year, has been designed as GSA's environmental demonstration project. It will be highly energy efficient, as well as having many innovative environmental features. Details of the energy savings and environmental features of this building also are being submitted for the record.

As a preplanned spinoff from the Manchester demonstration project, GSA developed a brochure called. "Guidelines on Energy Conservation for New Office Buildings." This document was first published in January 1974, and the demand for it has been so great that we had to bring out a second edition in July of 1975. To date, we have distributed or sold some 8,000 copies to other Federal agencies, State and local governments, foreign governments—Australia, England, France, Spain, Japan, and Canada—and to interested private parties.

[Document available for inspection in subcommittee files.]

Mr. Eckerd. The guidelines provide many ideas which should be considered in designing for energy conservation, and which contain information on variables associated with climatic differences. GSA is using these guidelines for new buildings that soon will be added to our inventory.

One of these is the new Federal building, which is well along in construction, in Topeka, Kans. It will be highly energy efficient and typi-

cal, we hope, of the new generation of buildings.

By 1979, we expect to have 26 new energy efficient buildings in operation, resulting in a very substantial annual cost avoidance for more than \$4 million a year. And I am very pleased to report that buildings designed for high energy efficiency are expected to cost no more initially than buildings designed according to conventional standards.

The large inventory of existing buildings, in both the public and private sectors, is far greater than the number of new buildings constructed in 1, 5, or even 10 years. So it is mandatory that we address the problem of energy conservation in the buildings we already have. If we do not, it will be many, many years before there will be a major

impact in the amount of energy consumed in buildings.

Much has been accomplished in existing buildings by the changes we have made in their operating standards and practices, such as cutting down the heat in winter and raising the temperatures in summer. We have reduced the amount of energy used by 27 percent from fiscal year 1973 to fiscal year 1975. And for the first three-quarters of fiscal year 1976, as compared to fiscal year 1973, we show a 27.8 percent reduction. In real terms, this reduction is equivalent to a savings of approximately 2,800,000 barrels of oil per year. The cost savings has been approximately \$40 million per year.

To further this program, we expect by the end of this month to have in print our "Energy Conservation Guidelines for Building Operations." It will be made available so that others can benefit from our ex-

perience to the greatest extent possible.

[Publication available for inspection in subcommittee files.]

Mr. Eckerd. There has been little capital investment to make this major reduction in energy usage in existing buildings. But we have gone just about as far as we can go through changes in operating pro-

cedures and practices.

Further significant savings can only come from capital investment for an extensive retrofit program. A 10-year plan has been developed to retrofit 50 percent of our most energy intensive space. This plan involves a total investment of \$140 million. But if we are able to fully implement it by 1985, we will achieve a \$20 million per year cost avoidance to be added to what we already are saving. This comes from a 15 percent savings per year in energy consumption. It translates into a savings of 1.6 million barrels of oil per year. It also translates into about a 14 percent ROI, return on investment, which isn't too bad considering that the Government can borrow money at an average of 8 percent.

A few retrofit projects have been undertaken already. However, the program is proceeding at a slow pace because of lack of funds. We will evaluate about 5 percent of our space for retrofit in fiscal year 1977, and increase this to between 10 and 15 percent in subsequent years.

And here again, to share our experience with others, we have published "Energy Conservation Guidelines for Existing Office Buildings." We are pleased that there has been heavy public demand for this document.

[Publication available for inspection in subcommittee files.]

Mr. Eckerd. GSA's efforts to conserve energy also extends to the large amount of leased space under our control. The lower lighting we put into effect in Government buildings also was applied to space under lease. This had to be done on a voluntary basis. And as an incentive, we did not try to reduce the rental payments when the lessors' energy costs dropped. As a result, we have had energy savings in leased property estimated at about 20 percent.

Beginning in January 1974, we insisted that energy conservation specifications be put into our new leases. And this has reduced energy

consumption by an estimated 30 percent.

In January 1975, we began requiring that buildings of more than 75,000 feet, constructed for lease to the Government, be designed to be as energy efficient as new, federally owned buildings. Lease awards have been made for 14 such buildings, with the combined energy savings, we estimate, at 40 to 45 percent. We believe this effort insures the

carryover of GSA innovations into the private sector.

Since solar energy is inexhaustible and nonpolluting, GSA felt it demanded attention as an energy source. Over the years, solar radiation has been looked on, for the most part, as a problem in the building and housing industry. Engineers have been more concerned with developing ways of keeping solar radiation out of buildings than with harnessing the available solar energy for its benefits. Consequently, there has been only token development in the use of solar energy in this country for many years.

We believe the time is ripe for a major expansion in its use for heating and cooling buildings. We realize much additional research and development is needed; and that moving forward will involve risk-taking on early installations. There will be some successes and some

partial failures. But we will learn.

And the potential benefit to the country, through the development of solar energy, justifies major efforts in that direction right now.

GSA is providing supplementary solar energy systems in its new buildings in Manchester and Saginaw. And we have a few other solar energy systems planned or under consideration. In fact, we are now looking into the feasibility of including a solar energy system as a part of the initial design of each new Federal building. When determined feasible, we hope to include a solar energy system as part of the project design—or at least provide for the easy addition of a solar energy system at a future date.

We are also studying existing buildings to see if it is feasible

to retrofit solar systems into some of them.

Solar energy systems have so much potential that we favor the installation of a sizable number of them on a continuing basis to support the developing solar industry, even though the payout time for such systems may be long. A market is necessary to stimulate the industry which in turn will advance the state of the art and, hopefully, reduce the cost of solar energy.

I am pleased that this committee is concerned about the solar energy conservation and, indeed, all energy conservation in the building industry. We feel that GSA has made significant progress in this area already. And we are committed to continuing the development of policies and programs to further this effort.

If you have any questions, we will be pleased to try to answer them

or to furnish the desired information for the record.

Mr. Ryan. Thank you very much, Mr. Eckerd. That is a very illuminating statement. I am particularly impressed by your plan to encourage the purchase of solar energy devices even though they may be, with the expected rapid change in the state of the art, obsolete before long in the interest of supporting the commercial development of solar energy machines. This, in other areas, may not have been the best approach, but I think it sets a good example for private industry to follow. I think that is important.

Early in your statement, you said that 38 percent of your space

is leased. Is there some reason for that?

Mr. Eckerd. This has been traditional in Government buildings. It is sometimes dependent upon appropriations. If we have an appropriation, we build; if we do not have an appropriation and need space, we lease.

Mr. RYAN. In other words, it comes down to capital outlay and the policy of the Appropriations Committee, rather than your particular

policy.

Mr. Eckerd. Yes, sir, we simply follow what we are instructed. The tendency in recent years has been to swing more toward leasing.

Mr. RYAN. You refer to the fact that the new buildings will have a higher efficiency. How do you arrive at that conclusion? What kind of criteria do you use?

For instance, do you consider the building materials?

Yesterday the president of the AIA Research Corp., Mr. Eberhard, talked about the fact that not enough is known about the thermal quality of different building materials. The assumption is that brick and mortar are the most energy efficient in the sense that they create the best thermobarrier.

We have buildings today that are built of glass and steel, both of which are less efficient in the thermal sense and which are also the kinds

of materials which cost more in an energy sense.

Do you take into consideration the costs of materials that you use for building in the sense of the energy used for their manufacture? Or do

you simply consider dollar costs?

Mr. Whitley. Mr. Chairman, we have taken a hard look to try to identify the energy that goes into building materials. We have not found a way, for example, to specify brick in relation to energy consumption—which you use as an example.

All forms of energy consumption must be considered. A plant which is relatively efficient and uses little energy, but which is 1,000 miles away from the construction site would be considered in relation to another plant which uses more energy in production but is close by.

Mr. RYAN. Then transportation is a part of the problem.

Mr. Whitley. Transportation gets involved. We realize the actual energy costs, including transportation and production, have gone up drastically. But we have more or less concluded that the marketplace will price out of competition the products and manufacturers which are not energy efficient.

Mr. Ryan. That is obviously an enormously complicated question

involving some pretty sophisticated economic principles.

Is there any work being done, that you know of, to develop any kind of measurement so that you can say, in your bid specifications, "The energy costs must not be higher than a certain amount per square foot"?

Mr. Whitley. If you are referring to the constructed building; yes, we have taken exactly that step. As a matter of fact, our basic approach to energy conservation in new buildings is not to develop a series of rules—thou shalt use so much insulation; thou shalt have a certain window size; or, it shall be double glazed. Instead, we have developed an energy budget for every new building which functions in exactly the same way as a financial budget. We give the designer of the building a budget—and the budget we have established is some 55,000 Btu's per gross square foot of building per year. That is a very stringent budget. I think the consumption in a typical building now runs somewhere around 200,000 Btu's per gross square foot a year.

So we give the designer an energy budget exactly the same way we give him a financial budget-and the designer works toward that goal.

Mr. Ryan. Obviously your requirements for some kind of leased space in International Falls, Minn., would vary drastically from, for example, a small naval headquarters building in Key West, Fla., having the same number of square feet.

In the one case, you are going to have some pretty fierce winters and some pretty short summers; in the other case, you are going to have very little problem with heating. But with that warm, wet climate in

Florida, the buildings will erode much more rapidly.

Mr. Eckerd. That is why we have a variable budget, Mr. Chairman. Also, the use of that building enters into our consideration when we set the energy budget for the construction of that building.

If we are building it for IRS or someone who operates 7 days a week and 24 hours a day and who has a computer facility, it obviously is going to greatly increase the per foot allowance that we are going to have to build in that building.

So we have to know the location of the building geographically, the type building it is, and the use the building is going to be put to before

we establish that.

Mr. RYAN. May we, for the record, have a specific example of that kind of energy cost?

I am really very pleased to hear this.

Mr. ECKERD. We will provide a specific example for the record.

Mr. Whitley. I would add also, since you cited a building in the North and one in the South, where the climates are quite different, that your requirements for hot water energy are about the same; your requirements for equipment such as typewriters and lighting are about the same. And all of your pumps and fans are about the same.

The real difference is heating and cooling. And it has actually been our observation that there is not as much difference as you might first expect between New England and Florida. For example, the sum of

the heating and cooling would be much the same.

In other words, in New England there is predominantly heating and a little bit of cooling. In Florida, there is predominantly cooling and a little bit of heating. And in the middle of the country, it might be more equally matched.

Mr. RYAN. In San Mateo County, Calif., we have reached that happy state.

Mr. Eckerd. Mr. Chairman, I lived in Erie, Pa., for about half of my life and in Clearwater, Fla., for the other half. And I can youch for it. The bills are about the same. What you make up in air-condi-

tioning, you lose in heating.

Mr. Whitley. And we know that as we move along, we will have to refine our budget. But the problem is now. We had to move out with our best judgment. And we have moved out on that basis. And when we get this unusual situation of the IRS's running 7 days a week, which Mr. Eckerd cited, we have to make adjustments.

Mr. Ryan. Since you have developed that policy, can you give me an example of a building where you have put an energy cost on it?

Mr. Whitley. Yes. We mentioned earlier in the testimony two

buildings where we have done that—Manchester and Saginaw.

And in fact, starting in 1974, every new building we began to design—and for new buildings that were already under design, but just started into the very early design—had applied to them that budget. And these buildings are just beginning to come on the line now, and will be coming on the line during the next 3 years.

I will have to tell you that we really do not have a single one of them on the line right now so that we could actually look at the bills, if

you will. What we have is the theory and the prediction.

The first buildings will be coming on this fall. And we will begin then to see whether in actuality they match our predictions. We are optimistic, but we do not have the buildings actually on the line yet.

Mr. Eckerd. I went through the building myself in Manchester, Mr. Chairman, when it was about 60 percent completed. And there are many innovations that have been tried there that have not been used before, and which would be hard to gage.

But I had the architect with me. He guaranteed 40 percent, but

said he was really shooting for 50 percent in savings.

He has completely reversed the skin. The insulation is on the outside instead of the inside, so he gets a carryover on the inside wall. With the other tenant agencies, we are experimenting with, I think, seven different types of lighting fixtures—one on every floor—and we are going to closely monitor the heat and energy consumption from the different lighting fixtures.

We do hope to get a lot of experience out of that experiment.

Mr. Ryan. I think you are moving in the right direction on that.

I am glad to hear about it because I think it will have an effect over a period of time.

I would like now to move to a different area which also concerns me. That has to do with the siting and the location of Federal build-

ings and federally used buildings.

It is true that some buildings must be in a particular place because of the nature of the building. You cannot put a lighthouse in Topeka, Kans. That would not do much good. And you cannot have an airplane terminal in the middle of the desert where nobody flies. That does not make any sense.

But a large portion of the functioning of the Federal Government

must occur in areas where there is heavy population.

I have noticed that the changing housing/living patterns in this country have produced some significant shifts in needs. I am speaking in particular of the air transportation problem and the transpor-

tation problem in general.

If I fly to New York for some kind of meeting with regional Federal people in the Federal buildings in New York, I go from here to La Guardia, and from La Guardia into town. The distance from La Guardia into town is the critical difference we are talking about as far as energy is concerned because of the means by which you must get there.

Originally New York was designed so that when you arrived there, you were right in the center of activity when you got off the ship at the Battery—a hundred years ago. Now that energy is a problem, the problem of transportation becomes of critical concern to the location.

In San Francisco, for example, the airport is 22 miles away. And most of the regional offices in San Francisco are far enough away to constitute at least 1 hour each way for anyone arriving there to take part in a regional conference. An hour there and an hour back is required.

What is being done, or what is being planned in the future, to relieve that particular kind of problem? And we are, of course, presuming that airplanes continue to fly past the time when you and I are concerned about Federal policy as it relates to buildings.

Mr. Peyton. Our concern up until this point has been with the eroding structure of the country's cities. The priorities that have been associated with the Federal Government's support to that particular aspect has dominated over the problem that you have cited.

We presently have a policy in the Administration to site new Federal buildings in the central business districts of the various cities and towns around the country. And we are following that policy.

Mr. RYAN. Why?

Mr. Peyton. As a spur or a stimulus to the redevelopment of downtown business areas which in many cities throughout the country have decayed. It has been the objective of the Administration to provide some sort of support to that. And our Federal buildings have been in the forefront of spurring redevelopment.

Mr. Ryan. You are saying, then, that the general policy has been to assist in the effort to avoid the collapse of the central city, where businesses are fleeing the central city to the suburbs, by relocating in

the central city yourselves.

Mr. Peyron. That is correct, sir.

Mr. RYAN. That is a very laudable kind of priority, but the question now raised is: Has that become too expensive when one considers the energy costs?

Has that been either reviewed or considered? Mr. Peyton. I really cannot tell you, sir.

Mr. Ryan, Mr. Eckerd, do you have any comment on that?

Mr. Eckerd. Many of our buildings are, of course, multipurpose

buildings. We have many agencies in there.

For example, suppose you located in Atlanta around one of the two limited access perimeters. It is going to be handy out there for one segment if you were to locate it on the south side, close to the airport. You would be handy to people who were coming in to deal with that particular agency.

But all of the local people who wanted to deal with it would have

to have transportation. You would have a tradeoff there.

In other words, I do not believe that the central core is as bad, Mr. Chairman, as you think it is if there is good mass transit into that central part. It is a tradeoff. It is not as handy to people who live on the west side, but it is a heck of a lot handier to people who live on the east side.

I do not think there is a simple answer to that, sir.

Mr. Ryan. This seems ridiculous to me. I confess that my experience is more particular with San Francisco than elsewhere; but, in San Francisco, you are right. The downtown area has pretty well collapsed.

But it collapsed at least as much because of previous Federal policy as anything else. It was the Congress and the executive branch that dreamed up the idea some 25 or 30 years ago to build all of these high-

ways leading out of town.

And then after they were building the highways leading out of town, they gave builders and potential buyers an incentive to go out there and buy new homes with a Federal Housing Administration loan that was cheap.

We did everything that we could toward that end. The result is that here in Washington, where I used to live as a kid a generation ago at 18th and Columbia Road—and it was a fairly nice neighborhood then—the people who live there are all out past the beltway.

There was no beltway then. But there is a beltway now, where all of the middle-class people live. There is a beltway in Baltimore; there is a beltway in Boston. If San Francisco were big enough, there would be a beltway there. But even there we have the freeways that go around the perimeter of the San Francisco Bay.

And I have a hunch that that has been done around most of the

cities of the country. And we have encouraged it.

Now if we are going to encourage the opposite direction by bringing Federal buildings downtown to help relieve some of this pressure, why do you not then bring the people with you?

This, I think, gets into the basic problem which your Administration has to face. You build these buildings back downtown, and then

you let the people run back and forth—as I do right now.

I live out past the beltway, near Montgomery Mall. And I drive back and forth on two Federal highways—the beltway and the George Washington Parkway—to get into town. Federal money has been used to make it easier for me to go back and forth.

There are two stoplights before I get to the bottom of Capitol Hill.

It is great.

But in the meantime, I have used, on a round trip, 4 gallons of gas per day. And there are millions like me—including yourselves,

probably.

There is no place to live down here. You keep building the buildings in the central cities to support the central cities, but the people themselves do not have an opportunity to live where they work. So if we are going to keep building in the central city, it seems to me that there ought to be a concurrent policy for providing living space.

What do you have in the way of plans or intentions to provide any kind of Federal example of the construction of multifunction

buildings?

And we do have those kinds of buildings in this country. We have one in San Francisco which is almost 20 years old—the Fox Plaza. There, the first 7 floors are made up of business and commercial offices and stores, and the next 14 floors are made up of apartments.

Mr. Eckerd. Sir, of course we work very closely with HUD in the development of our buildings to try and assure ourselves that there are homes available within that vicinity for the different classes of workers. And it depends a lot on who is going in there as to what type housing we have to have—whether it is to be low-cost, medium, high, or what the mixture should be.

Mr. Ryan. Can't you mix it up?

Mr. Eckerd. We have not gotten the authority from Congress yet, sir, to have multipurpose use of Federal buildings, for one thing. But there is no possibility for us to design a building and bring people into that.

Mr. Ryan. Would you do me a favor and make that recommendation to me?

Mr. Eckerd. We have already got a bill on the floor. You will have a chance to vote on it shortly.

Mr. RYAN. I am glad to hear it. I don't think you will have to worry

about us on this one.

Since 38 percent of your space is leased, have you made it part of the bid specification to give priority to leasing space which has all of the things you have to have, but which also has multiple function buildings so that it is possible for those who work in the area to walk or ride the elevator to work?

Mr. Eckerd. I think Crystal City would be a good example of that. In other words, the very thing that you are talking about did happen

down here at Crystal City.

Mr. RYAN. Is that a policy of your agency? Do you give more premium, for example, to a bid for space in the John Hancock Building in Chicago than you do to a building where there is not such space in the building?

Mr. Eckerd. We do not; no, sir.

Mr. Ryan. Do you have any plans to change that?
Mr. Eckerd. I think it is a very interesting idea.

Mr. RYAN. I am going to keep after you on this. If you are going to insist upon a rather arbitrary decision to help out the central cities because they are poor and because everybody left town, then you need to go further.

This is a little bit like King Canute's trying to hold back the water.

It has already happened. And we are part of it.

If you are going to get the middle class back downtown, you are going to have to provide more than a job to get them back downtown—

and if energy is a problem.

My concern in this subcommittee and in the conservation of energy is to get people out of their cars. And rapid transit is not the way to do it because rapid transit works only in areas where there is a high population concentration. And once you have high population concentrations, you may not even need rapid transit because there are better ways than that if a central city is designed properly with multiple function buildings.

There is no reason, for example, if we followed the example we have for the Japanese in Tokyo—at least in theory—for not having, as a

part of the Federal complex right here on Capitol Hill, apartments

available for rent to Members of Congress.

I can hear the press saying, "There go the fat cats trying to get some more for themselves." But that is more a matter of public rela-

tions as it relates to Congressmen.

But the fact is that there should be housing facilities available, not just for the Congress itself, but for the some 17,000 employees also. But I think if GSA were to take a survey right here on Capitol Hill to find out how many employees lived within walking distance to the Capitol that the answer would be absolutely appalling.

And yet, we are concerned about the conservation of energy and the transportation costs. That transportation cost is the largest, single unnecessary cost in the energy crunch that we have now. And it can be

overcome by different design.

Mr. Eckerd. We would have to have further direction, I believe, before we could really crank that into our figures.

Mr. Ryan. What do you mean by "further direction ?"

Mr. Eckerd. We would have to have further direction from the executive branch and, probably, from the Hill. Our mission now in leasing space is to lease the most desirable space at the least cost.

For example, if we were leasing space in Chicago, there is the Sears Tower which, I believe, has some home facilities in it. I think there are a certain number of floors in that building which have homes.

Mr. Ryan. Oh, yes; there are about 80 floors. It is 110 stories high. Mr. Eckerd. If we had an opportunity to rent a space, and needed space in that area, and had that building versus another building five blocks away; and the two were functionally comparable, but it cost \$1 more per foot to lease that space in Sears Tower, I think we would be-

not from you, sir-but I think we would be subject to severe criticisim for paying that additional dollar and trying to equate that to this energy thing which you are referring to. I think the newspapers would

Mr. RYAN. You are on the record. I think that is a legitimate criticism. If you do not feel you have enough authority, then that is the reason we have these committee hearings.

Mr. Eckerd. I think we could use some guidelines on that.

Mr. Ryan. I can guarantee you that one of the results of this committee's hearings will be as strongly as possible to recommend, first of all, to Government Operations as a full committee, to adopt this as a matter of policy.

And once that is adopted, I can guarantee you that there will be at least a resolution of this—perhaps legislation or whatever is required.

At that time, if I am the author—and if I am here, I will be—you will be invited back to assist me in saying what you have just said.

The only other questions I have relate to this same multiple function of Federal buildings. Was not the FBI building originally designed as a multifunction building?

Mr. Eckerd. I have only been in this job for 9 months.

Tom, do you know?

Mr. Peyton. I cannot believe that it would be, sir, because we do not presently have the authority to construct buildings of that character.

Mr. Ryan. Staff tells me that the first floor was designed to be used for shops and that sort of thing-before we went to the Orwellian concept of "Ils ne passerons pas," as I believe it was referred to in World War I.

Mr. Eckerd. This legislation which we have been asking for for 5

years, sir, has already passed the Senate. It is in Public Works.

Mr. Ryan. How do you feel about that? Is security a problem today? Mr. Eckero. I am for it. I think it is a very forward step. No. 1, I think we can get much higher rent on some of those first floors from the private sector. You might even rent them to a drugstore or something like that. Also, I think the public would like to see a building that encompassed all things.

Mr. Ryan. From the standpoint of design and people, I believe very strongly that we can no longer build slab-sided buildings, in single-purpose areas of a downtown area, which are awake 40 hours a week, that die in the evening, and that are closed all weekend. How can you have 40 hours of useful time out of 168 hours a week and call that en-

ergy efficient?

A building is most efficient, it seems to me, that is open 7 days a week and 24 hours a day. That is most efficient. Whatever energy costs it took to build that building, it is getting the maximum amount of use for the bricks and the mortar and the steel that is in it.

And as you go down and down from that, you get less and less

energy efficiency in construction costs.

My grandchildren are going to want to know from me—and from you—why we spent all of those natural resources building those buildings that are so costly. And they will have to try to find materials to take the place of that stuff that doesn't exist anymore, or that we have to import from thousands of miles distant from other countries that hold us up and extract from us a price we do not want to pay in order to get their raw materials.

Mr. Eckerd. I thoroughly agree with you, Mr. Chairman. And, of course, I think the same thing applies to churches and schools. Maybe

that is a better example.

Mr. Ryan. I agree with you completely. It is just that your authority and mine is limited to public Federal buildings, and that we do not have any authority over churches and schools. I think I am glad we don't.

Mr. Eckerd. So am I.

Mr. Ryan. But I think that we can at least by example show them

the way they must go. I think that is the reason we are here.

We thank you for the appearance of you and your staff, Mr. Eckerd. It has been very useful to me. The subcommittee staff and I intend to go over the testimony and pick it apart and find things to do and find ways to encourage you. Maybe you will do the same for me.

I will now recess the hearing to answer the quorum. I am pleased to have the appearance of Jack Brooks, who is chairman of the full committee and my boss, and who has nothing wrong ever to say.

We will recess for about 5 minutes.

[Mr. Eckerd's prepared statement follows:]

PREPARED STATEMENT OF JACK ECKERD, ADMINISTRATOR, GENERAL SERVICES
ADMINISTRATION

MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE: I AM JACK ECKERD, ADMINISTRATOR
OF GENERAL SERVICES. I APPRECIATE THE OPPORTUNITY TO DISCUSS THE IMPORTANT
POLICIES AND PROGRAMS WHICH GSA HAS DEVELOPED REGARDING ENERGY CONSERVATION.

WE, AT GSA, FULLY SUPPORT EFFORTS TO IMPROVE ENERGY EFFICIENT AND CONSER-VATION PRACTICES WHICH WILL CONTRIBUTE TO A SUCCESSFUL ENERGY PROGRAM. WE REALIZE, TOO, THAT A SIGNIFICANT PORTION OF OUR NATION'S ENERGY SAVINGS CAN BE ACHIEVED THROUGH CONSERVATION IN BOTH PUBLIC AND PRIVATE BUILDINGS.

GSA IS RESPONSIBLE FOR 10,000 BUILDINGS WITH AN INVENTORY OF 250 MILLION SQUARE FEET OF SPACE NATIONWIDE. OF THIS 250 MILLION SQUARE FEET OF SPACE, 62% IS GOVERNMENT-OWNED AND 38% IS LEASED. IN ADDITION TO OUR EXISTING INVENTORY, GSA CURRENTLY HAS 49 NEW CONSTRUCTION OR MAJOR ALTERATION PROJECTS IN THE PROCESS OF DESIGN OR CONSTRUCTION.

MAJOR AREAS OF CONCERN

AT GSA, OUR ENERGY CONSERVATION PROGRAM FOR FEDERAL OFFICE BUILDINGS HAS HAD FOUR MAJOR AREAS OF CONCERN:

- THE DESIGN OF ALL NEW BUILDINGS SO THAT THEY ARE HIGHLY ENERGY EFFICIENT;
- THE INSTITUTION OF BUILDING OPERATING STANDARDS AND PRACTICES IN
 THE LARGE INVENTORY OF EXISTING BUILDINGS TO REDUCE ENERGY USAGE;
- THE RETROFITTING OF OUR INVENTORY OF EXISTING BUILDINGS TO MAKE THEM MORE ENERGY EFFICIENT;
- THE USE OF SOLAR ENERGY AS IT DEVELOPS, TO PROVIDE BUILDING HEATING, COOLING AND HOT WATER.

DESIGN OF NEW BUILDINGS FOR HIGH ENERGY EFFICIENCY

IN 1972, WELL BEFORE THE OIL EMBARGO, GSA COSPONSORED WITH THE NATIONAL BUREAU OF STANDARDS A ROUNDTABLE ON ENERGY CONSERVATION. THIS ROUNDTABLE BROUGHT TOGETHER INFORMED REPRESENTATIVES OF BOTH THE PUBLIC AND PRIVATE SECTOR TO EXPLORE THE POSSIBILITY OF DESIGNING BUILDINGS TO OPERATE WITH REDUCED ENERGY USAGE.

AS ONE FOLLOWUP OF THIS ROUNDTABLE, THE NEW FEDERAL BUILDING AUTHORIZED FOR CONSTRUCTION IN MANCHESTER, NEW HAMPSHIRE, WAS DESIGNATED AS GSA'S ENERGY CONSERVATION DEMONSTRATION BUILDING. MUCH ATTENTION WAS GIVEN TO THE DESIGN OF THIS BUILDING WITH THE PURPOSE NOT ONLY OF DESIGNING FOR MINIMUM ENERGY USAGE, BUT TO ALSO DEVELOP CONCURRENTLY ENERGY CONSERVATION DESIGN GUIDELINES WHICH COULD BE USED BY THE DESIGNERS OF ALL FUTURE FEDERAL BUILDINGS TO MAKE THEM HIGHLY ENERGY EFFICIENT. WE SET OUT TO INITIATE A NEW GENERATION OF BUILDINGS WHICH WOULD OPERATE WITH 40 TO 50 PERCENT LESS ENERGY THAN THE TYPICAL MODERN BUILDING OF COMPARABLE SIZE LOCATED IN SIMILAR CLIMATE ZONES.

THE MANCHESTER FEDERAL BUILDING WILL BE COMPLETED AND OCCUPIED THIS CALENDAR YEAR. IT INCORPORATES MANY ENERGY CONSERVING FEATURES AND WILL, IN FACT, BE A LIVING LABORATORY FOR THE REAL WORLD TESTING OF ENERGY CONSERVATION FEATURES AND SYSTEMS.

AT THE BEGINNING OF THE DESIGN OF THIS BUILDING, WE SOUGHT IDEAS FOR ENERGY CONSERVATION FROM MANY SOURCES—OUR OWN ARCHITECTS AND ENGINEERS, THE NATIONAL BUREAU OF STANDARDS AND OTHER FEDERAL AGENCIES, NUMEROUS COLLEGES OF ARCHITECTURE AND ENGINEERING, TECHNICAL PROFESSIONAL SOCIETIES, MANUFACTURERS, ETC.

MANY OF THE IDEAS THUS OBTAINED WERE INCORPORATED IN THE BUILDING DESIGN. SOME OF THE ENERGY CONSERVATION FEATURES OF THE BUILDING ARE: UNUSUALLY WELL INSULATED WALLS, ROOF AND FLOOR OVER THE UNHEATED BASEMENT PARKING GARAGE; HEAVY WALL CONSTRUCTION TO SERVE AS A THERMAL RESERVOIR; LIMITED WINDOW AREA; DUAL GLAZING AND SPECIAL SHADING OF WINDOWS; HEAT PUMP SYSTEMS TO PROVIDE BOTH HEATING AND COOLING ON THE LOWER THREE FLOORS; DIFFERENT HIGH EFFICIENCY HEATING AND COOLING SYSTEMS ON EACH OF THE FOUR UPPER FLOORS; WASTE HEAT COLLECTIONS AND STORAGE FOR FUTURE USE IN THREE 10,000 GALLON INSULATED STORAGE TANKS; AND A SOLAR ENERGY SUPPLEMENTARY SYSTEM. MORE DETAILED INFORMATION ON THE ENERGY CONSERVATION FEATURES IS INCLUDED IN THE FACT SHEETS SUBMITTED TO THE COMMITTEE AS APPENDIX A TO THIS STATEMENT.

WITH FINANCIAL SUPPORT FROM THE FEDERAL ENERGY ADMINISTRATION, THE ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION AND THE NATIONAL BUREAU OF STANDARDS, THE MANCHESTER FEDERAL BUILDING IS BEING FULLY INSTRUMENTED TO PERMIT A FULL PERFORMANCE EVALUATION AFTER OCCUPANCY. THE NATIONAL BUREAU OF STANDARDS IN COOPERATION WITH GSA WILL MAKE THE PERFORMANCE EVALUATION. SUCCESSFUL FEATURES AND SYSTEMS WILL BE PUBLICIZED TO ENCOURAGE USE BY OTHERS.

THE SAGINAW, MICHIGAN FEDERAL BUILDING HAS BEEN DESIGNED AS GSA'S ENVIRONMENTAL DEMONSTRATION PROJECT. IT WILL BE HIGHLY ENERGY EFFICIENT AS WELL AS INCLUDE MANY INNOVATIVE ENVIRONMENTAL FEATURES. THE CONSTRUCTION OF THIS BUILDING IS ALSO NEARING COMPLETION AND IT WILL BE OCCUPIED DURING THIS CALENDAR YEAR. THIS SINGLE STORY BUILDING HAS EARTH BERMS AGAINST SOME EXTERIOR WALLS AND AN EARTH FILL AND PUBLIC PARK ON A PORTION OF THE ROOF WHICH WILL GREATLY REDUCE THE HEATING AND COOLING LOAD OF THE BUILDINGS. IT INCLUDES: A LOW-WATTAGE LIGHTING

SYSTEM; SINGLE-PIPE, SINGLE-TEMPERATURE WATER SERVICE TO LAVATORIES; COLLECTION AND USE OF RAINWATER; AND A SYSTEM FOR TREATING AND REUSING THE FLUSHING MEDIUM FOR TOILETS AND URINALS TO REDUCE WATER CONSUMPTION. MORE INFORMATION ON THE ENERGY CONSERVATION AND OTHER SPECIAL FEATURES OF THE SAGINAW FEDERAL BUILDING IS INCLUDED IN THE FACT SHEET, SUBMITTED TO THE COMMITTEE AS APPENDIX B TO THIS STATEMENT.

AS A PRE-PLANNED SPIN-OFF FROM THE MANCHESTER DEMONSTRATION PROJECT, WE DEVELOPED "GUIDELINES ON ENERGY CONSERVATION FOR NEW OFFICE BUILDINGS". THIS DOCUMENT WAS FIRST PUBLISHED IN JANUARY 1974 AND A SECOND EDITION WAS PUBLISHED IN JULY 1975. ALTHOUGH IT WAS INTENDED PRIMARILY FOR GSA USAGE, THERE HAS BEEN A GREAT DEMAND OUTSIDE THE AGENCY. TO DATE, APPROXIMATELY 8000 COPIES HAVE BEEN DISTRIBUTED TO FEDERAL AGENCIES, STATE AND LOCAL GOVERNMENTS, FOREIGN GOVERNMENTS (AUSTRALIA, ENGLAND, FRANCE, SPAIN, JAPAN, CANADA), AND SOLD TO OTHER INTERESTED PARTIES.

WE BELIEVE THESE GUIDELINES POINT THE WAY FOR THE CONSTRUCTION INDUSTRY TOWARD BUILDING DESIGNS AND SYSTEMS THAT WILL RESULT IN VERY SUBSTANTIAL ENERGY SAVINGS.

THE GUIDELINES ARE NOT A PANACEA FOR ALL ILLS. THEY ARE NOT PRESCRIPTIVE;

INSTEAD MUCH LATITUDE IS LEFT FOR THE DESIGNER TO MAKE DECISIONS IN THE INTEREST

OF AESTHETICS, FUNCTION, AND ENERGY CONSERVATION. THE GUIDELINES DO PROVIDE

MANY IDEAS WHICH SHOULD BE CONSIDERED IN DESIGNING FOR ENERGY CONSERVATION AND

PROVIDE INFORMATION ON TRADE-OFFS AND VARIABLES ASSOCIATED WITH CLIMATIC

DIFFERENCES.

WE BELIEVE IT IS FEASIBLE TO ESTABLISH AN ENERGY BUDGET FOR FEDERAL OFFICE BUILDINGS AS A RESTRAINT WHICH WILL ENSURE PRIME ATTENTION TO ENERGY CON-SERVATION IN ALL ASPECTS AND STAGES OF THE DESIGN. AN ENERGY BUDGET GUIDES THE DESIGN EFFORT IN A MANNER SIMILAR TO THE FAMILIAR CONSTRUCTION FINANCIAL BUDGET. THE ENERGY BUDGET BECOMES ONE MORE CONSTRAINT THAT TENDS TO DEMAND GOOD, THOUGHTFUL DESIGN.

THE "ENERGY CONSERVATION DESIGN GUIDELINES FOR NEW OFFICE BUILDINGS" ESTABLISHES AN ENERGY BUDGET GOAL OF 55,000 BTU PER GROSS SQUARE FOOT PER YEAR OF ENERGY INPUT AT THE BUILDING BOUNDARY, REGARDLESS OF LOCATION WITHIN THE COUNTRY. THIS WOULD REPRESENT A REDUCTION OF 50% FROM TODAY'S FIGURE OF 120,000 BTU PER GROSS SQUARE FOOT PER YEAR. SIMILARLY, THE GUIDELINES ESTABLISH AN ENERGY BUDGET GOAL OF 100,000 BTU PER GROSS SQUARE FOOT FOR RAW SOURCE ENERGY. THIS COMPARES WITH PRESENT CONSUMPTION OF 200,000 BTU PER GROSS SQUARE FEET PER YEAR. WE FEEL THIS IS A MAJOR STEP IN THE RIGHT DIRECTION BUT RECOGNIZE THAT THESE FIGURES AND THIS APPROACH MAY REQUIRE MODIFICATION AS WE GAIN MORE KNOWLEDGE AND EXPERIENCE. IN THE MEANTIME, WE ARE APPLYING THIS CRITERIA TO THE DESIGN OF ALL NEW GSA PROJECTS. BEFORE MOST BUILDINGS WERE DESIGNED WITH COST AS THE ONLY CONSIDERATION.

A NUMBER OF HIGHLY ENERGY EFFICIENT BUILDINGS, DESIGNED IN ACCORDANCE WITH GSA'S ENERGY CONSERVATION DESIGN GUIDELINES FOR NEW OFFICE BUILDINGS, WILL SOON BE ADDED TO GSA'S INVENTORY. NOTABLE AMONG THESE NEW BUILDINGS IS THE NEW FEDERAL BUILDING, WELL ALONG IN CONSTRUCTION IN TOPEKA, KANSAS. THIS BUILDING WAS NOT DESIGNED TO INCLUDE DIFFERENT HEATING, COOLING, AND LIGHTING SYSTEMS FOR THE INDIVIDUAL FLOORS FOR EXPERIMENTAL PURPOSES. HOWEVER, IT IS EXPECTED TO BE HIGHLY ENERGY EFFICIENT AND TYPICAL OF THE NEW GENERATION OF BUILDINGS.

BY 1979, WE EXPECT TO HAVE 26 NEW ENERGY EFFICIENT BUILDINGS IN OPERATION RESULTING IN A VERY SUBSTANTIAL ANNUAL COST AVOIDANCE OF OVER 4 MILLION DOLLARS A YEAR.

BASED ON OUR LIMITED EXPERIENCE TODAY, WE ARE PLEASED TO REPORT THAT BUILDINGS DESIGNED FOR HIGH ENERGY EFFICIENCY ARE EXPECTED TO COST NO MORE INITIALLY THAN BUILDINGS DESIGNED ACCORDING TO THE USUAL STANDARDS. THIS RESULTS FROM THE TRADE-OFFS INVOLVED. THE BUILDING EXTERIOR SHELL WILL COST 8 TO 10 PERCENT MORE BUT THERE WILL BE AN OFFSETTING REDUCTION IN THE COST OF THE BUILDING'S HEATING, COOLING AND LIGHTING SYTEMS.

WE ARE STILL SEARCHING FOR INNOVATIVE DESIGNS WHICH WILL RESULT IN MORE
ECONOMICAL AND MORE ENERGY EFFICIENT OFFICE SPACE. RECENTLY A FEASIBILITY
STUDY WAS COMPLETED ON A MEGASTRUCTURE—A LARGE BUILDING WITH AN AIR SUPPORTED
FABRIC ROOF. THE ROOF SYSTEM WILL BE MADE UP OF THREE SEPARATE FABRIC LAYERS
SO DESIGNED THAT THEY CAN BE READILY MODIFIED TO ACCEPT SOLAR RADIATION THROUGH
THE ROOF INTO THE BUILDING IN THE WINTER AND MODIFIED TO REFLECT SOLAR
RADIATION IN SUMMER. THIS TYPE BUILDING OCCUPIES A RELATIVELY LARGE AMOUNT
OF GROUND SPACE AND THUS WILL BE BEST SUITED TO AREAS WHERE LAND COSTS ARE
NOT HIGH. WE ARE STILL EXPLORING THE POSSIBILITIES OF THE MEGASTRUCTURE
DESIGN. MORE INFORMATION ON THIS PROPOSED INNOVATIVE DESIGN IS INCLUDED IN
THE FACT SHEET SUBMITTED TO THE COMMITTEE AS APPENDIX C TO THIS STATEMENT.
WE INTEND THAT MEGASTRUCTURE WILL BE A GSA DEMONSTRATION PROJECT OF THE FUTURE.

ENERGY CONSERVATION IN EXISTING FEDERAL BUILDINGS

BECAUSE THE LARGE INVENTORY OF EXISTING BUILDINGS IN BOTH THE PUBLIC AND PRIVATE SECTORS IS FAR GREATER THAN THE NUMBER OF NEW BUILDINGS CONSTRUCTED IN ONE, FIVE, OR EVEN 10 YEARS, IT IS MANDATORY THAT WE ADDRESS THE PROBLEM OF ENERGY CONSERVATION IN EXISTING BUILDINGS. OTHERWISE, A MAJOR IMPACT ON THE AMOUNT OF ENERGY CONSUMED BY BUILDINGS WILL BE MANY, MANY YEARS IN DEVELOPING.

MUCH HAS BEEN ACCOMPLISHED IN EXISTING BUILDINGS BY CHANGES IN OPERATING STANDARDS AND PRACTICES. ENERGY CONSUMPTION BY HEATING, COOLING, AND LIGHTING SYSTEMS IN GSA-CONTROLLED OFFICE SPACE HAS BEEN REDUCED FROM 61 TRILLION BTU'S IN FY 73 TO 44.7 TRILLION BTU'S IN FY 75. THIS IS A 27 PERCENT ENERGY SAVING WHICH REPRESENTS A COST AVOIDANCE OF AROUND \$40 MILLION PER YEAR. WHILE CONSUMPTION HAS DECREASED, OUR UTILITY COSTS HAVE INCREASED. FOR THE FIRST THREE QUARTERS OF FY 76 AS COMPARED TO THE SAME PERIOD OF FY 73, WE HAVE ACHIEVED A 27.8 PERCENT REDUCTION. ACTUALLY, OUR PERCENTAGE OF REDUCTION IS 30 PERCENT WHEN THE FIGURES ARE ADJUSTED TO CONSIDER ONLY THOSE BUILDINGS THAT EXISTED IN 1973. IN REAL TERMS, THIS REDUCTION IS EQUIVALENT TO APPROXIMATELY 2,800,000 BARRELS OF OIL PER YEAR.

THESE REDUCTIONS HAVE BEEN BROUGHT ABOUT THROUGH THE FOLLOWING ENERGY SAVING MEASURES:

- 1. CHANGING TEMPERATURE LEVELS IN GSA-CONTROLLED SPACE IN THE SUMMER TO 78° 80° AND IN THE WINTER TO 68° F.
- ELIMINATING HUMIDIFICATION CONTROLS AND REHEAT CYCLING DURING THE COOLING SEASON.

- MINIMIZING THE USE OF OUTSIDE AIR DURING EXTREME TEMPERATURE SEASONS AND MAXIMIZING USE OF OUTSIDE AIR DURING MODERATE TEMPERATURE SEASONS.
- PLACING GREATER EMPHASIS ON PREVENTIVE MAINTENANCE ON MAJOR EQUIPMENT TO MAINTAIN OPERATING EFFICIENCY.
- CLEANING GSA-CONTROLLED BUILDINGS BETWEEN THE HOURS OF 11:30 A.M. AND 8:00 P.M. TO CONSERVE ENERGY.
- CHANGING THE STARTING AND STOPPING TIMES OF HEATING AND COOLING SYSTEMS
 TO APPROXIMATE WORKING HOURS.
- 7. REDUCING ENERGY CONSUMPTION IN DATA PROCESSING AREAS -- HIGH ENERGY AREAS.
- 8. PROHIBITING THE USE OF PORTABLE FANS AND SPACE HEATERS.
- REDUCING LIGHTING STANDARDS IN FEBRUARY 1974, TO 50 FOOT-CANDLES AT WORK STATIONS, 30 FOOT-CANDLES IN WORK AREAS, AND 10 FOOT-CANDLES IN NONWORK AREAS.
- 10. REMOVING 3,250,385 FLUORESCENT TUBES THROUGH FY 75 FROM THE 10,000 GSA OWNED AND LEASED BUILDINGS. (THE NUMBER OF FLUORESCENT TUBES REMOVED SINCE FY 73, WILL RESULT IN AN ANNUAL SAVINGS OF 425 MILLION KILOWATT HOURS OF ELECTRICITY--EQUAL TO 850,000 BARRELS OF CRUDE OIL.)

11. ELIMINATING EXTERNAL LIGHTING OF BUILDINGS EXCEPT FOR SAFETY AND SECURITY PURPOSES.

IN ORDER TO FURTHER THIS PROGRAM, WE EXPECT BY THE END OF THIS MONTH TO HAVE IN PRINT OUR "ENERGY CONSERVATION GUIDELINES FOR BUILDING OPERATIONS". THIS DOCUMENT WILL BE AVAILABLE FOR USE BY OTHER FEDERAL AGENCIES, STATE AND LOCAL GOVERNMENTS, AND OTHER INTERESTED PARTIES IN ORDER THAT OTHERS MAY BENEFIT FROM OUR EXPERIENCE TO THE BROADEST EXTENT POSSIBLE.

THE MAJOR REDUCTION OF ENERGY USAGE IN THE INVENTORY OF EXISTING BUILDINGS
TO DATE, HAS BEEN ACCOMPLISHED WITH LITTLE OR MINIMAL CAPITAL INVESTMENT.
HOWEVER, WE FEEL WE HAVE ACCOMPLISHED ABOUT AS MUCH AS WE CAN THROUGH CHANGES
IN OPERATING STANDARDS AND PRACTICES.

TO MAKE FURTHER SIGNIFICANT SAVINGS, CAPITAL MUST BE EXPENDED FOR AN EXTENSIVE RETROFIT PROGRAM. A 10-YEAR PLAN HAS BEEN DEVELOPED TO RETROFIT 50 PERCENT OF OUR MOST ENERGY INTENSIVE SPACE. THIS PLAN REQUIRES A TOTAL INVESTMENT OF \$140 MILLION AND INVOLVES THOSE GSA OWNED AND OPERATED BUILDINGS WITH A RAW SOURCE ENERGY CONSUMPTION OF 150,000 BTU/GROSS SQUARE FOOT/YEAR OR MORE. IF WE ARE ABLE TO FULLY IMPLEMENT THE PLAN BY 1985, WE WILL ACHIEVE A \$20 MILLION PER YEAR COST AVOIDANCE WHICH REPRESENTS A 15 PERCENT ADDITIONAL SAVINGS PER YEAR IN ENERGY CONSUMPTION. WHEN ADDED TO THE SAVINGS ALREADY MADE, THIS WILL MEAN A TOTAL \$60 MILLION PER YEAR COST AVOIDANCE AND A 45% SAVINGS PER YEAR IN ENERGY CONSUMPTION. THESE SAVINGS EQUATE TO 4.8 MILLION BARRELS OF OIL EQUIVALENT PER YEAR WHEN THE PROGRAM IS COMPLETE.

APPROXIMATELY FIVE PERCENT OF OUR SPACE WILL BE EVALUATED FOR RETROFIT IN FISCAL YEAR 1977. THE EVALUATION WILL BE INCREASED TO BETWEEN 10 AND 15

PERCENT IN SUBSEQUENT YEARS, UNTIL THE MOST ENERGY INTENSIVE SPACE HAS BEEN STUDIED FOR RETROFIT.

A FEW RETROFIT PROJECTS HAVE BEEN UNDERTAKEN. HOWEVER, THIS PROGRAM IS
PROCEEDING AT A SLOW PACE BECAUSE OF LACK OF FUNDS. WE FEEL THAT IT IS
ESSENTIAL THAT ENERGY RETROFIT PROGRAMS BE IDENTIFIED AND PROGRAMMED SEPARATE
FROM, AND IN ADDITION TO, GSA'S NORMAL REPAIR AND ALTERATION PROGRAM.

TO ASSIST IN THE IMPLEMENTATION OF THE GSA ENERGY RETROFIT PROGRAM, WE HAVE PUBLISHED "ENERGY CONSERVATION GUIDELINES FOR EXISTING OFFICE BUILDINGS".

LIKE THE GSA GUIDELINES FOR NEW BUILDING DESIGNS, THERE HAS BEEN A CONSIDERABLE PUBLIC DEMAND FOR THIS DOCUMENT.

LEASED BUILDINGS

OUR EFFORTS TO CONSERVE ENERGY EXTEND TO THE LARGE AMOUNT OF LEASED SPACE UNDER OUR CONTROL. THESE ENERGY EFFORTS WITH REGARD TO LEASING ACTIVITIES ESSENTIALLY FALL INTO TWO CATEGORIES: (1) SPACE LEASED IN BUILDINGS WHICH HAVE BEEN CONSTRUCTED PRIOR TO GSA'S LEASING ACTION (EXISTING BUILDINGS) AND, (2) SPACE IN BUILDINGS THAT ARE CONSTRUCTED AS A RESULT OF GSA'S LEASING ACTION (LEASE CONSTRUCTION).

GSA APPLIED ITS DELAMPING AND ADJUSTMENT PROGRAM TO BUILDINGS OR SPACE CURRENTLY UNDER LEASE TO GSA IN THE SAME MANNER AS GOVERNMENT-OWNED BUILDINGS IN GSA'S INVENTORY. SINCE THIS INVOLVED PROPERTY OWNED BY INDIVIDUAL LESSORS, IT WAS ACCOMPLISHED ON A VOLUNTARY BASIS. AS AN INCENTIVE TO COOPERATION, GSA MADE NO ATTEMPT TO REDUCE RENTAL PAYMENTS WHEN THE LESSOR'S ENERGY COSTS DROPPED. ENERGY SAVINGS ARE ESTIMATED AT 20 PERCENT AS A RESULT.

BEGINNING JANUARY 1974, OUR SOLICITATIONS FOR LEASED SPACE INCLUDED SPECIFICATIONS TO ENSURE THAT THE ENERGY CONSERVATION MEASURES ADOPTED FOR GOVERNMENT OWNED BUILDINGS BECAME CONTRACTUAL OBLIGATIONS OF THE SUCCESSFUL OFFERORS. IT IS ESTIMATED THAT THIS HAS REDUCED ENERGY CONSUMPTION BY ABOUT 30 PERCENT.

COMMENCING IN JANUARY 1975, THE DESIGN CRITERIA FOR LEASE CONSTRUCTION PROJECTS OF 75,000 SQUARE FEET OR MORE, WERE REQUIRED TO BE COMPARABLE TO THOSE USED IN THE DESIGN OF NEW FEDERALLY-OWNED BUILDINGS. LEASE AWARDS HAVE BEEN MADE FOR 14 SUCH BUILDINGS WITH THE COMBINED ENERGY SAVINGS ESTIMATED AT 40 TO 45 PERCENT. IN ADDITION, STEPS ARE BEING TAKEN TO REDUCE THE SIZE OF BUILDINGS SUBJECT TO THESE CRITERIA TO 20,000 SQUARE FEET. WE BELIEVE THAT THESE EFFORTS INSURE THE CARRYOVER OF GSA INNOVATIONS INTO THE PRIVATE SECTOR.

USE OF SOLAR ENERGY

SINCE SOLAR RADIATION IS INEXHAUSIBLE AND NON-POLLUTING, IT DEMANDS ATTENTION AS AN ENERGY SOURCE.

TO A LARGE EXTENT, OVER THE YEARS SOLAR RADIATION HAS BEEN LOOKED UPON AS A PROBLEM IN THE BUILDING AND HOUSING INDUSTRY. ENGINEERS HAVE BEEN MUCH MORE CONCERNED WITH THE DEVELOPMENT OF WAYS OF KEEPING SOLAR RADIATION OUT OF BUILDINGS THAN IN HARNESSING THE AVAILABLE SOLAR ENERGY FOR THE BENEFIT OF MANKIND. FOR EXAMPLE, THEY HAVE REDUCED THE HEAT LOSS/HEAT GAIN THROUGH BUILDING EXTERIORS THROUGH THE USE OF IMPROVED INSULATION AND VARIOUS TYPES OF GLASS DESIGNED TO MINIMIZE ENERGY TRANSFER. THIS IS GOOD BUT THE POTENTIAL POSITIVE ASPECTS OF SOLAR ENERGY SHOULD ALSO BE FULLY CONSIDERED.

THERE HAS BEEN ONLY TOKEN DEVELOPMENT AND USE OF SOLAR ENERGY IN THIS COUNTRY FOR MANY YEARS. FREQUENTLY, IT HAS BEEN CONSIDERED MORE OF A NOVELTY THAN A VALID USE OF AN IMPORTANT RESOURCE. WE, IN THE GENERAL SERVICES ADMINISTRATION BELIEVE THE TIME IS RIPE FOR A MAJOR EXPANSION IN THE USE OF SOLAR ENERGY IN THIS COUNTRY TO HEAT AND COOL BUILDINGS. THE TECHNOLOGY AND HARDWARE IS BECOMING AVAILABLE WHICH WILL PERMIT MAKING LARGE SOLAR ENERGY INSTALLATIONS. HOWEVER, IT SHOULD BE EMPHASIZED THAT MUCH ADDITIONAL RESEARCH AND DEVELOPMENT IS NEEDED TO IMPROVE THE TECHNOLOGY AND BRING DOWN THE COSTS. IMPROVED HARDWARE WILL BRING ABOUT IMPROVED EFFICIENCY.

MOVING FORWARD WILL INVOLVE JUDICIOUS RISK TAKING ON EARLY INSTALLATIONS AND WILL ADD TO THE INITIAL COST OF THE STRUCTURE. IN THESE PIONEERING EFFORTS, COSTS ANALYSES MAY BE MISLEADING BECAUSE OF THE IMPOSSIBILITY OF ACCURATELY PREDICTING THE PRICE OF THE CONVENTIONAL FUELS, FIVE, TEN, OR THIRTY YEARS IN

THE FUTURE. REALISTIC COMPARISIONS ARE FURTHER COMPLICATED BY THE FACT
THAT MOST ECONOMIC ANALYSES DO NOT RECOGNIZE THE NEED FOR PRESERVING THE
REMAINING SUPPLY OF CERTAIN VITAL FOSSIL FUELS, OR THE BALANCE OF PAYMENTS
PROBLEMS AGGRAVATED BY THE IMPORTATION OF LARGE AMOUNTS OF OIL AND NATURAL GAS.

AS MAJOR SOLAR ENERGY INSTALLATIONS ARE MADE TO TRY OUT NEW HARDWARE AND TECHNIQUES, THERE WILL BE SOME SUCCESSES AND SOME PARTIAL FAILURES. BUT WE MUST REALIZE THAT ENGINEERS OFTEN LEARN AS MUCH FROM FAILURES - IN THE LONG RUN - AS FROM MODEST SUCCESSES. THE POTENTIAL BENEFIT TO THE COUNTRY THROUGH THE DEVELOPMENT OF SOLAR ENERGY JUSTIFIES MAJOR EFFORTS IN THAT DIRECTION NOW.

WE ARE COOPERATING WITH THE ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION IN THEIR SOLAR HEATING AND COOLING DEMONSTRATION PROGRAMS. AS MENTIONED EARLIER, SUPPLEMENTARY SOLAR ENERGY SYSTEMS ARE BEING PROVIDED ON BOTH OF GSA'S DEMONSTRATION PROJECTS - THE NEW FEDERAL BUILDINGS IN MANCHESTER, NH AND SAGINAW, MI. BOTH SOLAR SYSTEMS ARE EXPECTED TO BE OPERABLE DURING THE COMING 1976-77 WINTER HEATING SYSTEM. THEY WILL PROVIDE A SUBSTANTIAL AMOUNT OF THE ENERGY REQUIRED TO HEAT, COOL AND PROVIDE HOT WATER IN THESE TWO BUILDINGS. THE TECHNOLOGY FOR USING SOLAR ENERGY TO PROVIDE BUILDING HEATING AND HOT WATER IS WELL ALONG IN ITS DEVELOPMENT. CONSIDERABLY MORE DEVELOPMENT IS NEEDED IN THE SOLAR COOLING AREA. BREAKTHROUGHS ARE BADLY NEEDED TO REDUCE THE COST OF SOLAR SYSTEMS.

GSA HAS A FEW OTHER SOLAR SYSTEMS PLANNED OR UNDER CONSIDERATION. IN FACT, WE NOW CONSIDER THE FEASIBILITY OF INCLUDING A SOLAR ENERGY SYSTEM AS A PART OF THE INITIAL DESIGN OF EACH NEW FEDERAL BUILDING. WHEN DETERMINED FEASIBLE, WE HOPE TO INCLUDE A SOLAR SYSTEM AS PART OF THE PROJECT DESIGN. AT A

MINIMUM, PROVISIONS WILL BE MADE FOR THE EASY ADDITION OF A SOLAR SYSTEM AT SOME FUTURE DATE.

THE FEASIBILITY OF RETROFITTING SOLAR ENERGY SYSTEMS TO SELECTED EXISTING BUILDINGS IS ALSO UNDER CONSIDERATION IN GSA. STUDIES HAVE BEEN MADE OF 10 MAJOR BUILDINGS TO DATE AND OTHERS WILL BE CONSIDERED IN THE FUTURE.

SOLAR ENERGY SYSTEMS HAVE SO MUCH POTENTIAL THAT WE FAVOR THE INSTALLATION OF A SIZABLE NUMBER OF INSTALLATIONS ON A CONTINUING BASIS TO SUPPORT THE DEVELOPING SOLAR INDUSTRY EVEN THOUGH THE PAY OUT (AMORTIZATION) TIME FOR SUCH SYSTEMS MAY BE LONG. A MARKET IS NECESSARY TO STIMULATE THE INDUSTRY THEREBY ACCELERATING ADVANCEMENT IN THE STATE-OF-THE-ART AND, HOPEFULLY A REDUCTION IN THE COST OF SOLAR SYSTEMS.

THIS CONCLUDES MY PREPARED STATEMENT. I AM PLEASED THAT THIS COMMITTEE
IS CONCERNED ABOUT ENERGY CONSERVATION IN THE BUILDING INDUSTRY. WE FEEL
THAT GSA HAS MADE SIGNIFICANT PROGRESS IN THE ENERGY CONSERVATION FIELD.
FURTHERMORE, WE ARE COMMITTED TO CONTINUING THE DEVELOPMENT OF POLICIES
AND PROGRAMS TO FURTHER THIS EFFORT. IF YOU OR MEMBERS OF THE COMMITTEE
HAVE ANY QUESTIONS, I SHALL BE GLAD TO ANSWER THEM AT THIS TIME OR FURNISH
THE DESIRED INFORMATION FOR THE RECORD.

Appendix A

ENERGY CONSERVATION DEMONSTRATION PROJECT FEDERAL BUILDING, MANCHESTER, NEW HAMPSHIRE

SELECTION

The new Federal Office Building being constructed in Manchester, New Hampshire, was designated as the GSA Energy Conservation Demonstration Building on October 3, 1972.

PURPOSE

The purpose of this project is to: (a) dramatize the firm commitment of PBS/GSA to the conservation of energy in the design, construction and operation of Federal buildings; (b) provide a laboratory for the installation of both recognized and innovative energy conservation techniques/equipment; and (c) inspire others in the building construction industry to pursue energy conservation as a goal.

GENERAL DESCRIPTION

The building will be 7 floors in height and have a two level basement parking garage.

Approximate Gross Area	176,000 sq. ft.
Approximate Net Area	131,000 sq. ft.

Principal Occupants

Veterans Administration
Department of Defense
Department of Housing and Urban Development
Department of the Treasury
(Plus 7 additional minor occupants)

Approximate Building Population	418
Site Size	42,437 sq. ft.
Approximate Construction Cost (less Solar System)	\$8,729,373
Approximate Solar System Addition Cost	\$ 431,760
Total	\$9,161,133

DESIGN APPROACH

A professional services contract was awarded to Nicholas Isaak and Andrew C. Isaak, Architect-Engineers (A/E) of Manchester, New Hampshire, for the design of the project on November 7, 1972. In addition, the firm of Dubin-Mindell-Bloome Associates, was engaged on December 4, 1972, to serve as Energy Conservation Consultants (ECC) for this project. Further, the National Bureau of Standards (NBS) was added to the design team to perform detailed computer studies and to participate in the instrumentation and evaluation of the building. The ECC was responsible for the collection, evaluation, and selection (with GSA concurrence) of energy conservation features to be included in the project. The ECC worked closely with the A/E, NBS and GSA.

SCHEDULE

Provide Energy Conservation Input for Concepts Complete Working Drawings		1973 1974	
Award Phase I (excavation and foundation piles)	May	1974	(A)
Award Phase II (Building Superstructures except solar	Feb.	1975	(A)
collector and certain interface work) Complete Phase II		1975	
Award Phase III A (Purchase of Energy Instrumentation and		1976	
Supervisory Control System) Complete Phase III A (Fabrication only)		1974	
Start Phase III B (Installation of the Energy Instrumentation & Supervisory Control System)			
Complete Phase III B		1976 1976	
Award Phase IV (Solar collector plus interface equipment)		1976	
	0000	13/0	1-1

EXPECTED ACCOMPLISHMENTS

The completed building is expected to make a positive contribution to its urban surroundings and provide a pleasant interior environment for employees and visitors.

The completed building is expected to operate with at least 40 percent less energy consumption than other comparable existing buildings. It will demonstrate Energy Conservation Features in the following areas/systems:

- -Basic Architectural Design Configuration, Orientation, Fenestration, Insulation (small site limits somewhat the possibilities in configuration and orientation)
- -Mechanical-Space Conditioning
- -Electrical and Lighting

3

-Plumbing

Various systems will be installed on different floors of the building.

EVALUATION

Plans for the project include the full field evaluation of the innovative features after occupancy, based on built-in instrumentation and occupant reactions. Successful innovations will be publicized to encourage use elsewhere.

Appendix A

ENERGY CONSERVATION DEMONSTRATION PROJECT FEDERAL BUILDING, MANCHESTER, NH

FEATURES & SYSTEMS DESIGNED FOR INCLUSION IN PROJECT

- Building configuration, orientation, fenestration including shading; insulation; wall mass, etc., will be controlled to reduce the energy required to operate the building.
 - a. Upper floors of building will be as near square as site will reasonably permit (135 feet by 115 feet).
 - b. Lowest office floor will be immediately over basement garage levels thus avoiding exposure of underside of lowest floor to outside weather extremes.
 - c. U-Value for walls .06 (Normal 0.4 0.2)
 - d. U-Value for roof .06.
 - e. U-Value for floor directly over basement garage .06.
 - f. No windows in North Wall.
 - Windows on East, West and South Walls limited to an area in the 10-15 percent range.
 - h. Exterior wall mass 80-100 lbs/sq.ft. (normal 20-30 lbs/sq.ft. for curtain wall construction).
 - Exterior wall incorporates shading for windows designed to minimize summer radiant energy load.
 - j. Windows; double glazed, designed to minimize infiltration.
- 2. Location of Building Core Elements.
 - a. Core elements (stairs, elevators, toilets, mechanical rooms, etc.) located adjacent to North exterior wall - do not require close environmental control.
- 3. Mechanical-Electrical Systems.
 - a. Different systems on various floors to permit direct comparison of performance and efficiency. All systems included are expected to be energy efficient. We were unable to include all systems considered energy efficient in a single small demonstration project.

(2)

- No reheat air-conditioning system included.
- c. Types of systems by floors.

Floors 1, 2, and 3.

Exterior zones served by unitary closed loop water-to-air heat pumps, with variable volume boxes in branches from main distribution supply ducts.

Interior zones served by similar packaged heat pumps, with variable volume control.

Economizer cycle provided with outdoor air controlled by an enthalpy controller which senses both temperature and humidity.

All variable volume systems to be of the "by pass to return" type so there is full air flow across refrigerant coils at all times.

Rejected heat from all heat pumps operating on the cooling mode during occupied periods piped to large insulated hot water tank, which serves as the heat source for heat pumps operating on the heating mode at night, etc., when heating is required.

Floors 4, 5, 6, and 7.

Variable volume system on roof to serve interior zones of all four floors.

Floors 6 and 7, provided with four pipe perimeter units, but arranged to operate as either two-pipe or four-pipe system. Units draw air from ceiling plenum to make use of heat-of-light for heating during occupied periods.

Floors 4 and 5 provided with a separate air handling units for perimeter zones, arranged for variable volume, with vaned inlet fan control.

- d. Central chillers for floors 4 thru 7 normally driven by a gas engine generator. Waste heat from engine generator used to operate an absorption chiller. Condenser water from both chillers piped to heat storage tank and to cooling tower. Heat will be used to maximum extent possible; otherwise condenser water will be cooled by tower.
- Waste heat used for space heating at night, and for domestic hot water.
- f. Gas engine generator disconnected from chiller and used to provide emergency power for building during emergency blackout situation.

(3)

- g. Chillers undersized in relation to peak load. Operated at night when electrical load light and production of chilled water more efficient to store up chilled water in insulated tank for use next day during peak load period.
- h. Boilers and pumps of modular type to permit operation of only required number to gain maximum efficiency.

4. Solar Energy System.

- a. Solar collector will be mounted on the building roof areas.
- Weather station included for simultaneous collection of local weather information.
- Utilizes same hot water storage tanks, etc., already included for waste heat.
- d. Solar energy system is expected to provide from 20 to 30 percent of energy required for hot water and heating/cooling the building.

5. Lighting.

- Different systems on various floors to permit direct comparison of performance and efficiency.
- b. One floor with uniform high pressure sodium lighting; one floor may be provided with task lighting built into furniture; one floor with non-uniform, fluorescent relocatable, task-oriented lighting. Remaining floors with uniform fluorescent lighting of varying types.
- c. One floor provided with larger windows for experiment with natural light for perimeter of building.

Operation of building planned to minimize energy usage: Examples follow:

- a. Minimize after hours maintenance and custodial operations which would require energy usage for lighting and for environmental conditioning.
- b. All ventilation fans may be shut off 10 minutes of every hour.
- c. Temperatures of corridors, restrooms, equipment and storage rooms will be allowed to vary to 60 degrees F in the winter and 85 degrees F in the summer.
- d. Temperature set back (5 to 10 degrees) may be utilized one hour before closing time in the winter, in addition to other energy savings by not maintaining comfort conditions at night.

(4)

- During periods when cooling is required, higher temperatures than current standard design practice will be accepted.
- f. The building will be flushed out with 100 percent cool night air (down to 65 degrees) when appropriate conditions exist during the summer season.
- 7. Evaluation of Building Performance and Energy Usage.
 - a. The building is being fully instrumented to facilitate the collection of data and evaluation of the energy requirements of the building as a whole and of the various mechanical, electrical and lighting systems installed on different floors of the building. The National Bureau of Standards, with participation by GSA, will evaluate the performance of the building and its subsystem for a three year period after initial building occupancy. Employee reaction to the building environmental systems will be included in the evaluation.

Appendix B

PROJECT - SAGINAW, MICHIGAN FEDERAL OFFICE BUILDING

Prospectus Approval (Revised)

House: 9-9-65 5-2-74

Senate: 7-12-65 6-20-74

Project Description

The project provides for a reinforced concrete structure. The slightly depressed single story building will be situated in a park-like setting with an ecological roof designed to enhance the local environment. Approximately 60% of the roof will serve as a parking deck which will accommodate 70 of the 97 project parking spaces. The other additional 27 spaces are on-grade and in the maneuvering area.

Approximate Gross Area 59,000 sq. ft.

Principal Occupants
U. S. Postal Service
Department of Defense
Department of Treasury
Department of Health, Education & Welfare

Approximate Building Population 185

Total Site Size 125,514 sq. ft.

<u>Site Costs</u> \$1,086,900

Design and Review Cost (Funded FY 1967) \$595,800
Estimated Management & Inspection Cost \$146,500

Estimated Construction Cost \$4,948,000

Estimated Total Project Cost \$6,868,400

Site Data

Site - 450 ft. along Warren Avenue, 596 ft. along Weadock Avenue, with a depth of 240 ft. Lapeer Avenue, between Weadock and Warren Avenues has been closed. The site contains an area and the provision of additional green space appropriate to the purpose of an environmental building.

Design & Construction Status
The original design was completed by Smith, Hinchman & Grylls Associates, of Detroit on March 20, 1974. Bids for construction of the project were received on October 22, 1974, and rejected on November 20, 1974, because all bids exceeded the funds available within the authorization authority established by the congress.

> The Construction Management Division of GSA Region 5 (CMD of Region 5) located in Chicago, Illinois, undertook comprehensive studies to determine changes which could be made to the design to reduce cost, while retaining the environmental features of the project. Upon approval of the recommended changes, the CMD of Region 5 was authorized in February 1975 to redesign the project.

Schedule

Construction -	Award Demolition Contract Request Proposal from CM Firms Award CM Contract Complete Demolition Contract Award Construction Contract Construction Completion	4-75 (A) 5-75 (A) 6-75 (A) 7-75 (A) 6-75 (A) 7-76 (A)
Landscaping & Site Develop- ment	Complete Design Documents Award Contract Completion	10-75 (A) 1-76 (A) 7-76 (E)
Solar Collector	Design Start (Concepts) Complete Proposal to ERDA for Funding Complete Design Documents Award Contract Complete Solar Collector Construction Complete Data Collection and Analysis Complete Publication of Final Report	10-75 (A) 10-75 (A) 3-76 (A) 5-76 (A) 11-76 (E) 11-77 (E) 6-78 (E)

Evaluation

The project will include many innovative environmental and energy conservation features. These innovative features will be subjected to a full field evaluation after the building is occupied to determine performance and occupant reaction. Successful innovations will be publicized to encourage use elsewhere.

Appendix B

ENVIRONMENTAL DEMONSTRATION PROJECT FEDERAL OFFICE BUILDING, SAGINAW, MICHIGAN

FEATURES/CONCEPTS DESIGNED FOR INCLUSION IN PROJECT

A. ENHANCE THE ENVIRONMENT

1. OUTDOOR

- (a) Design creates a park for residents of area with planting around the building and planting on approximately one-third of the roof. Roof landscaped area will be accessible at all times from the surrounding sidewalks - not through building.
- (b) All parking is hidden from view from surrounding streets and sidewalks. (Exception: 14 spaces for short term parking for Post Office patrons and visitors.) Additional roof area can be landscaped if parking can be reduced in future.
- (c) Post Office manuevering area, loading platform and trucks screened from view to prevent image of an industrial facility.
- (d) Parking areas on portions of the roof designed for play area for neighborhood children after hours. Arrangement will include provision for tether ball and people moving monopoly. Portions of parking could also be used for public parking after hours.

2. INDOORS

- (a) Excellent working environment. Large open spaces to facilitate "office excellence" layout.
- (b) Full window walls at most locations to provide open vista to outside for building occupants.

B. USE OF RECYCLED MATERIALS

- A limited number of reclaimed brick from demolished buildings on the site will be used in the construction, where appropriate.
- Aluminum used in the building construction will be either recycled or from the national stockpile. In either case, the energy needed for production will be less than for aluminum refined from new ore.

C. WATER REQUIREMENTS AND RECYCLING

- Rainwater will be collected from around building and possibly from roof parking areas (if oil and salt is found to present no serious problem) for use for lawn sprinkler.
- Flushing medium for toilets and urinals will be purified and recycled thus eliminating the need for municipal water for this purpose.
- Requirements for municipal water will be minimal for drinking and lavatories only.
- Single-pipe, single-temperature water will be supplied to lavatories.

D. SOLAR ENERGY

 A large solar collector is included. Solar energy system is expected to provide all the domestic hot water required for the building and much of the building heating and cooling, thus saving normal fuel sources while operating pollution-free.

E. ENERGY-EFFICIENT DESIGN

- Low heat gain/heat loss through walls, some of which are protected by earth berms.
- Dual glazed windows protected from the summer solar load by large overhangs.
- Low heat gain/heat loss through roof, one-third of which will have earth fill and planting with remaining two-thirds of heavy construction.
- 4. Low wattage lighting systems.
- 5. Single story building requiring no elevators.

Appendix C

GSA's MEGASTRUCTUPE CONCEPT

A feasibility study of a megastructure concept has recently been completed for the U.S. Public Buildings Service, General Services Administration. The concept provides a controlled environment for Federal office space, public service facilities and possibly commercial, cultural, educational and recreational activities.

The environment consists of a large volume, clear-span space surrounded by a raised earth slope which is landscaped to preserve the natural environment. The space is roofed by a "sky" fabricated from lightweight man-made materials. The characteristics of the roof system can be changed so that it accepts solar radiation in winter and reflects solar radiation in summer to avoid a heat buildup within the structure. The covering spans an area 400 feet by 1000 feet, supported by internal air pressure slightly higher than that outside. The pressure is maintained by six 38" fans, only three of which would operate continuously.

Inside the structure three levels of usable space are arranged in an informal but efficient manner to accommodate a wide range of uses. The area not thus occupied is landscaped much like an urban park. The arrangement of spaces is expandable and highly flexible. Ten service cores at strategic locations provide vertical circulation, toilet facilities, mechanical and electrical system centers and exits for emergency egress.

Security and safety concerns are adequately covered by the concept, which requires some slight adjustments in the traditional approaches to those user needs.

Structure for the "sky" consists of one-way cables anchored in the surrounding earth berm. In the highly remote possibility of total collapse (complete deflation would take four hours) the roof structure and fabric would be supported by special cables strung between the service core towers.

Heating, ventilation and air-conditioning needs are served by two systems: one a perimeter system concerned with the large air mass in Megastructure, the other a series of local systems branching out of the service cores and serving the many varied work spaces.

Much of the electrical requirement is eliminated by the abundance of natural light and the low three-story configuration, as opposed to the many floors of a conventional high-rise office building.

Energy conservation is a major advantage of Megastructure. A current GSA design objective is an annual energy consumption budget of 55,000 btu per net square foot per year. This concept calculates at 44,000 with the possibility of reaching 33,000.

Comparative construction cost studies based on an initial phase of 350,000 net square feet and a final phase of 500,000 show the megastructure costing about the same as a conventional high rise office building - actually a percentage point or two higher (\$22,257,000 versus \$21,475,000 in 1975 dollars). However, the additional 150,000 net square feet for Megastructure would cost \$3,295,000 compared to \$13,829,000 for the conventional structure. A 30 year life-cycle cost analysis credits Megastructure with a \$16,500,000 saving; if commercial-type investment credits were also computed, that saving would exceed \$36,000,000. Economic benefits are many, based on rapid, weathersheltered construction, low operating and maintenance costs, incremental expansion and internal expansion.

Because of its inherent size and siting characteristics, locations for Megastructure open new possibilities in urban and regional planning.

GSA is interested in the development of this concept which can provide a warm and receptive environment for visitors, workers and the public at large while effecting economies in construction, maintenance and operation. A short recess was taken.

Mr. RYAN. We will continue now with the Energy Research and Development Administration, with Mr. Gerald S. Leighton, Assistant Director for Communities and Buildings Energy Systems.

Mr. Leighton, you have, I presume, heard the testimony of the previous witness and the comments and questions raised, and are aware of the general direction of the committee's concern.

With that, we are ready to hear your testimony.

STATEMENT OF GERALD S. LEIGHTON, ASSISTANT DIRECTOR FOR COMMUNITIES AND BUILDINGS ENERGY SYSTEMS, DIVISION OF BUILDINGS AND COMMUNITY SYSTEMS, ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION: ACCOMPANIED BY DR. MEL-VIN H. CHIOGIOJI, ASSISTANT DIRECTOR FOR SYSTEMS ANALY-SIS AND TECHNOLOGY TRANSFER

Mr. Leighton, Mr. Chairman, I want to express my appreciation for being here today and to discuss with you our research program.

in energy conservation for buildings.

I have provided a detailed statement for the record and would like to summarize my statement briefly. Before I do that, I would like to introduce Dr. Chiogioji, who is the Assistant Director for Systems Analysis and Technology Transfer in our Division.

The revised national plan for energy research, development, and demonstration, ERDA 71-1, was submitted to the Congress on April 15 of this year. It assigns the highest national priority to the development of conservation technologies along with certain key supply options.

Before getting to the core of today's hearing; that is, R. & D. concerned with design and construction of buildings only, I would like to take a moment to touch on the overall conservation program in ERDA.

In conservation, we have three divisions making up the supporting technology area of research and development and three end-use divisions.

The Division of Energy Storage focuses its efforts on providing technological research and support in the areas of batteries, chemical storage systems, and thermal and mechanical storage systems.

The Division of Conservation Research and Technology is responsible for the development and commercialization of fuel cells; and for undertaking research and development in the area of heat cycle technology, combustion technology, and heat transfer.

The Division of Electric Energy Systems focuses its efforts on the electric utility industry with research being undertaken in connection with improved transmission efficiency and reliability.

In the end use area, we have the Division of Industrial Energy Conservation whose program is focused on improving the efficiency of industrial and agricultural processes.

In the transportation area, that Division is charged with improving the efficiency of highway as well as nonhighway transportation

systems.

In the Division of Buildings and Community Systems, we are concerned with the research, development, and demonstration activities which will foster acceptance of energy savings technology and promote more effective energy use in buildings, community systems, and consumer products.

The buildings and community systems sector of society today consumes the equivalent of about 12.5 million barrels of oil per day.

Mr. Ryan. What percentage of the total consumption is that?
Mr. Leighton. That is about one-third of the national consumption.
That is what goes into buildings.

Mr. Ryan. That is a more digestible figure for the lay person.

Mr. Leighton. We are in a program that is directed at several thrusts, including the early demonstration of hardware and getting some technology in place.

In addition to that, we are trying to establish a good base upon which we can make decisions and get a good understanding. I think at least one of these activities is right in line with your interests.

We established last year, a program to determine what the energy input is in a building from beginning to end—what it takes to mine materials, to manufacture materials, to transport materials, and to put the materials into the building. Then we can determine how much energy it takes to operate the building.

We are also trying to address the other question at the tail-end of everything. When somebody decides the building is going to be torn down in 40 years, what is going to be the energy and environ-

mental impact of getting rid of that building?

The first results are starting to come in. The complete report will be available at the end of this year. And based on that information, we will be able to get more deeply into energy standards for buildings.

Mr. Whitley from GSA spoke about their 55,000 Btu's per square foot. That is an operating budget for the building. We are hoping to take that the next step and say: "OK, here is an energy target. But when you use that energy target, remember what it took to get those materials into the building." We think that is a very important step in the process. And that work is almost completed.

We awarded a contract to AIA Research Corporation last year and asked them to document the entire decisionmaking process in the buildings industry. We asked: Who makes decisions when? Where are the soft points we can probe and push on to get energy conservation built in? Who are the key actors, and at what point in the process?

That report has been completed in draft. It is now in print and the complete report and an executive summary will be available very

shortly.

We have several other activities that we can get out and kind of kick the harware and see what is going on. One is the annual cycle energy systems program. We feel it has a lot of potential not only for saving energy, but for helping the utility industry reduce its peak demands.

The ACES system can significantly reduce energy input requirements to a lot of buildings in the country. The ACES system heats a building by extracting energy from water with a heat pump.

While it is extracting the energy, the water is being cooled and eventually forms ice. So in the summer, instead of using new primary energy to run a compressor, you melt the ice and cool the building.

I think the commercialization is outstripping our research program. We have done a lot of work at Oak Ridge National Laboratory. And

this week we are cutting the ribbon on our demonstration house at the University of Tennessee.

A builder in Richmond, Va., heard about the concept and built a

house with the ACES in it.

For \$5,000, I think, we are helping to instrument and evaluate the

house, but he built the house and he is going to market it.

The Veterans' Administration got very interested in ACES. They took bids on a nursing home in Wilmington, Del.—a 60 bed nursing home-both with and without the ACES system. The bid came in within their budget for the ACES, and they are building that nursing home with the annual cycle energy system in it.

So we have a base research program going on, but the commercializa-

tion is very strong.

Mr. RYAN. May I hold you right there while I go over to the floor? Mr. Leighton. Yes.

Mr. Ryan. We will recess for a few minutes.

[A short recess was taken.]

Mr. RYAN. You may continue, Mr. Leighton.

Mr. Leighton. The ACES system is moving quite well. Commercialization is happening, and that is what we like to see in our

programs.

One of our major objectives—and this isn't in my testimony—is to see how fast we can work ourselves out of a job on any one of the projects. How fast can we get out of it and let the private sector take it and run with it and make a profit.

There are several other activities we have taken on in this first year

of the program.

Mr. RYAN. May I break in for a moment since you are about to leave

In talking about the ACES program, where you essentially shift

back and forth, how significant do you think that is?

We have heard one witness, who is about to be funded by your agency, I believe, testify about solar energy and a means by which we can implant a \$200 manufactured device on the roof of the average, single-family residential home and cut them loose from the powerline.

Is this that kind of thing? Is it widely applicable?

Mr. Leighton. The ACES is quite applicable around the country. It better fits in that part of the country where the heating requirement is about the same as the cooling requirement because then you just cut your energy requirement in half.

It turns out that a wide belt of the country fits this-New York, almost up to Boston, Washington, Knoxville, Atlanta, and through

the Midwest-and you have that type of condition.

Mr. Ryan. Do you already have a map that plots those areas?

Mr. Leighton. That is one of the major activities. One of the activities that is still going on at Oak Ridge in the research activity is to put out a handbook that we can turn over to the architects and engineers. And it will say: "Where are you? If you are there, you need this size tank, this size heat pump; this is what it ought to cost and this is what the payback is. So go tell your client that it is either a good deal or that he is out of his mind."

That handbook is one of the major outputs of the research program. We have a program going with the Mission Viejo Co. and a southern

California gas company on what is termed the "minimum energy development." The tip of the iceberg is two demonstration houses. But in reality, the biggest part of the program is the design technique—the new tools for design.

Up until now, for homes in particular, when energy was cheap, nobody really worried about designing the equipment. You made sure that the furnace or the air-conditioner that went in would, under

any situation, always meet the requirements.

As it turns out, you really do not need that. Buildings have a thermal lag and you don't have to size it that way. We are starting to approach the problem from the point of view of what the real energy requirements are. Do you have to have confidence that when you have the hundred years storm that the house is still going to be absolutely at 68 degrees instead of dropping to 67 degrees?

That is a little ridiculous. We can live a couple of hours or a couple

of days at 67.

Mr. Ryan. The British do it regularly. They wear sweaters.

Mr. Leighton. They wear sweaters; or, if it gets too hot they open the windows. And people can live that way. I do not think it is necessary to always be guaranteed that conditions are going to be that precise. There is a little give and take on this.

I know we are running short of time, but I would like to go through

a couple of highlights.

Not only are we working in the United States, but we are trying to leverage our money wherever we can get the best payback. We are working through international groups, such as the International Energy Agency and the North Atlantic Treaty Organization and the

Center for Buildings in Rotterdam.

One program which we embarked on, which I think is interesting, is this. The Federal Republic of Germany is energy short, as well as we are. They are looking at a major program centered on large heat pump systems. One heat pump system is servicing three high-rise buildings of about 400 dwelling units. It extracts the energy from a nearby river.

The project is truly a research project. They have a standby oil-fired system. So you can turn the heat pump system off and fire the oil system to see if there is really a difference in the energy consumption.

The buildings have different levels of insulation; there are different types of end delivery systems. Some of the apartments have radiant heat; some have the under-the-window fan coil units; some have radiators.

The other facility is a sports complex—an ice skating rink/swimming pool complex. And again, the heat pump is used. Basically, it is a large ACES system which is instant. They make the ice using the heat pump. And instead of throwing the heat away, they heat the building and the swimming pool. They move the energy around that

The German Government put in about \$5 million to date in that project. We bought into the project. We are getting all of the data and are involved in the research program for an investment of \$240,000. So I think we have a pretty good bargain in that research activity. And that was one of the first major things for conservation in the International Energy Agency activity.

There are a lot of agencies that have responsibilities in achieving energy conservation in buildings-HUD, GSA, Department of Commerce. And we have a rait of interagency agreements to make sure that our program gets directed to meeting their needs and that they become an implementor of the technology that we are putting out. It is a two-way street.

And we have interagency coordinating groups that work quite ef-

fectively to try and eliminate unwarranted duplication.

Farlier in your questions, Mr. Chairman, you indicated an interest in the dual use of areas and buildings. We have an agreement with HUD, with HUD transferring money, to help us in a program of getting back and looking at the basic idea or basic premise of community design. How do you really design communities? What are the purposes? What kinds of facilities should be located togetherresidential, commercial, office space? What are the transportation requirements

What should we do so that we can start living in a civilized mode instead of Operation Big Switch. In Operation Big Switch, you put the factories in the suburbs and put the blue-collar workers in the city.

And they drive out in the morning.

You put the white-collar workers in the suburbs and you put the offices downtown. And they drive in in the morning.

We have traffic jams in both directions and nobody is getting

anywhere.

But we are going a little bit further than community design with current technology. We are taking a preliminary look at some longrange efforts. There is one thing that strikes us in many cases. It is something that we all do; and we have watched people do it for years. And it seems a little bit ridiculous.

For this illustration, let's look at New York. People live in Westchester and Long Island and in different places. Some take the train, and others get into their cars and fight their ways into town. They pay the tolls; they pay \$7 a day to park; they go to the offices and

spend 3 days a week on the telephone.

Why did they come to the office? They could have stayed out in the suburbs and used telecommunications. They could have saved the energy; they could have not gotten the ulcer from fighting the traffic up and back; and, they could have saved money.

We are starting to take a very hard look at the possibility of, in some areas, the substitution of telecommunications for transportation.

What does that mean in community design? Can you run businesses from the suburbs-without everybody having to be at the central core office? Can you use the telecommunications to bring the benefits of the city—the entertainment and the education—back out to the suburbs? Can you make it desirable for people to still live there, but have the benefits of close-in living?

Mr. Ryan. That would significantly cut down the transportation. Mr. Leighton. Yes. And the substitution of communications is

cheap energywise.

Mr. RYAN. We built the transportation system in this country around the assumption that energy was cheap and that energy was totally available. Now we know that energy is not cheap and we know that energy is not totally available.

And now we have to begin to climb back down at a slower pace so that we do not do too much damage in the societal sense.

Mr. Leighton. There is something of interest which we try to do in every program. And I guess it is most important to look at this in telecommunications or in the community systems program.

We have outlined for ourselves a management tool which we call a program approval document. Every fiscal year, we really restate the programs for the area—the types of contracts we are going to let; what our goals are.

And we take that up to the Administrator. It is a signed contract between our office and the Administrator. And that is the program for

the year.

We lay out a series of steps for every research activity, including a

step that we call technology assessment.

And that is exactly the point you are making—be careful; hurry slowly. We may do very good things, but let's make sure we are not getting into problem areas. We have to be careful in telecommunications not to build in a problem that will surface 10 years from now.

So we try to take a look at where the technology fails. We know how it is going to succeed; that is why we are doing it. But what are the

pitfalls? How does it fail?

And that technology assessment step is built into every element of our program. It is right up front in the program approval document; it is keyed in everywhere.

At this point, Mr. Chairman, I would get away from my statement

and see if I can answer any questions you may have.

Mr. Ryan. First of all, what is the current budget of ERDA? Mr. Leighton. I think the current budget is in the neighborhood of \$6 billion.

Mr. Ryan. That is a lot of cookies.

Mr. Leighton. We have to take \$3 billion out for the military.

Mr. Ryan, I am not going to take \$3 billion out for the military. That implies the acquiescence of ERDA in that if the military says they want it, ERDA will say "OK." And ERDA doesn't fight about it. I want to know how that budget and those budget priorities are put

If ERDA is military, what in the name of God are we doing in giving them \$3 billion of nonmilitary funds? This is not part of the military budget. This is part of the civilian budget.

Why is the military messing around in an essentially nonmilitary kind of activity—even if there are military spinoffs? What is done

with their \$3 billion?

Mr. Chiogioji. I can partially answer that, although not fully.

Mr. RYAN. Please do.

Mr. Chiogioji, Basically, that primarily relates to special weapons research. I am not fully cognizant of exactly what is going on. But I am sure we can get the information for you and submit it for the record.

Mr. RYAN. We would like to have you submit it for the record. And I would like to verbally tell you here that I intend to later ask you for more specific answers. And bring in whomever you need from the military to help back it up.

If we are taking energy research money and spending half of it for military purposes, I want to know what those military purposes are and how they relate to the average guy's attempt to exist under these new rules where he doesn't have enough gas and enough oil and enough heat to be comfortable.

You have said that these funds relate to special weapons research.

Mr. Chiogioji, Yes; and weapons production also.

Mr. RYAN. And weapons production?

Mr. Chiogioji. Yes, sir. It was part of the old AEC structure.

Mr. Ryan. Oh, ERDA assumed some authorities of the old Atomic Energy Commission.

Mr. Leighton. That is the core of the ERDA organization; yes, sir. Mr. Ryan. So that is what you call "reorganization." We will get into that later.

So half of the budget is for military and for, I suppose, nuclear

Mr. Chiogioji. That is primarily where it is: yes, sir.

Mr. Leighton. A good part of the money is in fossil energy research, the solar heating and cooling research, geothermal research, and the advanced research activity such as controlled thermonuclear activities. And then we get down to conservation.

Mr. RYAN, I am certain that if it involves that kind of thing, then the policy as to how much goes in that direction is largely determined here in the Congress. I could probably give you the names of the ones with the big sticks and the swords and the lightning bolts and who are throwing it all in that direction.

That was the last generation of the Congress. They are disappearing very rapidly. There is a new one coming up. And I say that for the record. And if anybody reads this and wants to know something about that, that is where we are, based upon the new understandings and difficulties we have.

Having settled that half of the budget, how do you determine how

the other half is spent? How is that done?

Mr. Leighton. The process in the agency—and I do not think it is much different than other agencies—goes back to an initial target figure for the fiscal year which is provided from the Office of Management and Budget and the President.

Within the agency, a determination is made on how we want to push the various fronts-the conservation and the supply options that should move together. The assistant administrators in the various areas put together what they think should be in the program. And normally, it is a good wish-list which is on the fat side.

Mr. RYAN. Obviously it is a continuing dialog between the agency experts and the policymakers in the White House, and, I suppose in the Congress too, who have enough push to be able to grind their own axe a little more and somebody else's a little less. That is just the way

those things work.

I guess what I am trying to get at is that it seems that the budget which you presently have reflects prejudices of the past, but does not mirror the present or the future. The best example is that of atomic energy. That, in the present state of the art, is a limited, transitory kind of energy source. And we need to get something which is much more basic and which we know will be cleaner and will last longerwhether wind or solar, or both, or whatever. Atomic energy will not be around 100 years from now, or probably even 50 years from now.

I am asking these questions because primarily I think that this committee needs to identify the areas which are not being given enough attention.

Mr. Leighton. One of the things the agency is trying to do is to develop a procedure that would put some business judgment on the decisionmaking process. We, as the new boys on the block in conserva-

tion, were given this task last year.

Dr. Chiogioji did most of the work in developing a series of threshold criteria steps to look at our own program. When given a series of projects from our project managers, we asked: Why undertake the program? Does it save energy? Does it save coal? Does it save natural gas? We had to start making these choices.

And it went all the way through to saying: Why should the Federal Government be involved at all? Is the private sector doing it? If the answer is "yes," can the Government accelerate the time to bring the

technology into the marketplace?

If that answer is "yes" how much oil do we save by doing that?

What is the return on the investment?

And on that basis, we have screened out projects which seemed very good. But when we really put the hard numbers to them, we found that some did not have a payout. And industry would not implement the program.

The agency is now trying to take that, as well as other techniques, and to try to apply it across the board. They are trying to apply it in an interprogram way between the supply and the conservation options.

So instead of just the intuitive or the inherent prejudices, there is a

good, rational business judgment that is the starting point.

There will be certain things that are done independent of business judgment. We include projects which show no payout today. But we look at it and say, "10 years from now we are going to need some of that technology. So we had better spend a little bit in that area."

It is happening, but not overnight.

Mr. RYAN. Business judgment is great—up to a point. But there is a point beyond which it becomes slavish worship of a nonexistent kind

of theory.

If business judgment is what has brought us this far—or anywhere near it—then I worry about business judgment. Business judgment can decide whether to open the store tomorrow, or what lines of products to sell, based upon consumer resistance or acceptance; but, past a certain point, it falls off rapidly in effectiveness.

How much money is being spent by your agency in what I would

call "social research?"

I hate the use of the word "social" because of the goofy connotations it carries. But the fact is that what people do, what they are willing to accept, how far they are willing to go, and what they want becomes terribly important when you are talking about changing society's habits and customs. And that is exactly what we are talking about.

Mr. Leighton. The dollars being spent in that area are not large at all. They are minuscule. But we have an area, which we call "Con-

sumer Motivation and Behavior."

We started immediately a program of trying to see what people respond to. What makes things happen? If we have new technology, why will they buy it?

Or, are we going to get into the situation of regulating the use of technology? And the minute you lift the regulations, are they going to say, "Business as usual?"

We have to know what makes people do things. But the money is

not large.

When we started the overall conservation program in 1976, we had essentially one project at Twin Rivers, N.J., investigating what psychologists called "the mechanism of feedback."

In other words, what do people respond to? If they get information every day, will they start changing their way of doing business?

And that was a \$100,000 effort at Princeton.

In 1977, we are planning to spend about \$400,000 for a program which is being formulated now. We will be working with a lot of other agencies. We will be working with HUD on low-income housing and try to see what the motivations are in that area—particularly in areas where people do not pay for utilities.

We have other work that will be going on, a continuation of the work at Princeton University, in the middle-income areas. What will make people buy the technology and use it? What really motivates

them? Do they really believe there is a problem?

But this area is starting to move very slowly. And I would not

argue that more effort in that area would hurt.

Mr. Ryan. Does anybody talk about things such as this? Let's suppose that we find the most energy efficient, both in manufacture and use, kinds of building materials. And let's suppose that these are brick and mortar. We then provide some kind of premium or incentive for building with brick and mortar. And the Federal Government says that we are going to build with brick and mortar from now on and use a minimum of other kinds of materials.

But suppose that years later we find out that, like the Pruitt Aggo Development in St. Louis, nobody wants to live in it. And they will be damned if they will, even if you order them into it. Or even if you give them some kind of premium for just staying there, they still will not go. They would rather have substandard dwellings—shacks—to live

in than the kinds of buildings that are built for them.

That mistake could have been avoided by a little bit of digging into

peoples' heads to determine what they like.

Let me apply a parallel. I am convinced that we will not begin to resolve the problem of housing, which represents one-third of the cost of energy in this country today, until we resolve the idea about living and working in the same place.

Theoretically, that is where the human being began. He fished and hunted in the same area where he lived—or reasonably close. If he couldn't he moved his house or his dwelling to where the fishing or hunting was good. That is called nomadic living. That is from the

sixth grade and I still remember it.

Now, we began changing our habit patterns to fit what was a more convenient way to do it. But it seems to me that if we are going to change habit patterns in a society which is as sophisticated as the Western World, particularly the United States, and have some impact upon it, there has got to be some determination as to the feasibility of whether or not people will actually live in a new Federal policy which says that we will now begin to rent our 38 percent of leased space for

Federal purposes. And one of the criteria will be putting the offices in buildings where there are residential facilities available for the workers themselves within walking or, let us say, bicycling distance.

And I suppose we need to have social research to find out what the bicycling distance is. How far will people ride a bike before it is too

far? I don't have any idea and I suppose no one else has.

But even for the purposes of Federal employment—the largest employer—we don't have any idea of how to go about setting design and criteria. And we should be getting into that.

Do you know if there is anybody advocating more money in that

area? Is this being done in your agency?

Mr. Leighton. Yes, sir, and we are spending more. What you are addressing is not what we call "consumer behavior;" it is what we call

"community design."

And we do have several major activities going on, both with HUD and by ourselves, trying to get an understanding of what happens when you reexamine the whole community process. And instead of just worrying about roads, hospitals, schools, and sewers, we are putting energy in as another major parameter. What are the impacts? What are the desires? What are the benefits? And what are the negatives?

We are working very closely with HUD because their new communities program may give us a very good opportunity for really dem-

onstrating some of the theories that we come up with.

We are trying to look not only at the mistakes and the progress in this country, but we are looking outside the United States where cities are still quite viable and where people do live in the cities pleasantly.

And new towns have developed in Europe where you work, you live, you walk, and you ride bicycles. Why has the process worked there; and

why have we failed in getting it to work here?

And we are trying to look at what the institutional arrangements have been to make it successful. Are they applicable? Or do we have to come back to the Congress and demonstrate the benefits and ask for legislation?

We are very willing to come back and ask for that if the research

shows that there is promise—a carrot—at the end.

So the two areas of consumer behavior and community design are

very interrelated.

Mr. Ryan. There are already demographic changes taking place, and of which we are not aware enough of here. For example, about 2 years ago the percentage of single-family residences constructed was less than 50 percent. And the 50-percent line was passed by apartment units being built.

Thirty years ago, I would guess that not more than 25 percent, if that much, of the housing being built consisted of apartments. The

heavy, heavy emphasis was on single-family residences.

The attitude was: "Go out in the country, young man. Get your own little house with a picket fence and a little wife and a couple of kids, and do all of those great things."

Mr. Leighton. That was the Great American Dream.

Mr. Ryan. And the Great American Dream came true for my generation. We got out there. But we found that we had to build a new police station, a new school, new streets, and new sewer plants.

And we had to fight the weeds. We had side yards that were too narrow and a back yard that was too big to take care of. And we found, with great disillusionment, that it wasn't what we thought. That was my generation.

The kids, as they grow up and become of income-earning age, are not buying that jazz. The Great American Dream, it turns out, had too much hay fever in it. And what they want now is something else

entirely.

With the right kind of imaginative work, it may be that the Federal Government can actually come in on where the American people are already going anyway.

A previous witness said that we have to keep that central city concept going and we have to help them out. Even if it's no good, we have

to go there. Baloney.

But it may be that with the redesign and with the rethinking of Federal building principles and standards, we can come in on what is obviously the desire of people today to move into different kinds of living accommodations—including condominiums.

Twenty years ago, if somebody had said "condominium," somebody else would have said, "gesundheit," I suppose. Neither the law nor the concept existed. I know that because I was on a city council where

we had to wrestle with that.

When looking at it now, it seems to me that there is enough on already that ERDA itself ought to be putting out some imaginative ideas that consist of more than boiling water and taking temperatures and things like that. This is too much the tendency of the pure scientist who wants to deal in small amounts that are easily absorbed by individual people working on a particular project.

Somewhere near the top level of ERDA, I think there ought to be people who are cranky and ornery and who keep asking difficult questions. And I do not see enough of that going on. I think that ERDA ought to be the one that does the kicking around of other agencies—

including GSA—and asking why things are being done.

There should be some agency within ERDA which asks questions about why half of the money is spent for nuclear energy when in fact that may not be the way to go.

Is there any such group alive in ERDA?

Mr. Leighton. There is not a group on that level which kicks other agencies; no, sir. There is a group internally.

Mr. RYAN. Who do we have to get to get one in operation? Who do

we have to talk to?

Mr. Leighton. Dr. Seamans.

Mr. RYAN. I was hoping you would say that. And I would suggest to you and tell you that Dr. Seamans is next, as far as I am concerned, to appear before this subcommittee. And we will talk about that kind of thing.

I just think that we are piecemealing ourselves to death. We are not doing enough that is significant and that has enough impact upon Federal Government policies, let alone the American people them-

selves.

I say that in spite of the fact that some of the things you have said this morning give me hope that there is at least room for hope.

The staff and I have more questions. In view of the hour, however, and in view of the call to the floor, we will submit the additional questions to you in writing and ask for your response. Is that agreeable?

Mr. Leighton. Yes, sir.

Mr. RYAN. Thank you for your appearance here today. The hearing stands adjourned.

[Mr. Leighton's prepared statement follows:]

PREPARED STATEMENT OF GERALD S. LEIGHTON, ASSISTANT DIRECTOR FOR COMMUNITIES AND BUILDINGS ENERGY SYSTEMS, DIVISION OF BUILDINGS AND COMMUNITY SYSTEMS, ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

Mr. Chairman and Members of the Subcommittee

I appreciate this opportunity to briefly present the Energy Research and Development Administration's RD&D program in the Buildings and Community Systems area particularly as it relates to the design and construction of buildings. With me is Dr. Melvin H. Chiogioji, Assistant Director for Systems Analysis and Technology Transfer.

ERDA has given conservation high importance. The current National Plan for Energy Research Development and Demonstration (ERDA 76-1) submitted to the Congress, April 15, 1976, assigns highest national priority to development of conservation technologies along with certain key supply options. Major elements of the ERDA program include efforts to reduce energy consumption in buildings through more efficient space conditioning and utilization of waste heat; to achieve greater efficiency in processes used by energy intensive industries; to develop technologies in converting waste to energy or to synthetic fuel; and to exploit potential energy savings in transportation. The increased priority has been demonstrated in the Administration's budget requests for FY 1977, which included a 60 percent increase for conservation research and development.

I will now give you a brief summary of the overall programmatic thrusts of the ERDA conservation program.

The Office of Conservation was reorganized in July of this year after our one year 'shakedown'. The reorganization indicates the separation between end use activities and supporting technology. The end use divisions are:

- Buildings and Community Systems Industrial Energy Conservation
- Transportation Energy Conservation

The technology divisions which support the overall activities of the Office of Conservation are:

- Energy Storage Systems
- Conservation Research and Technology
- Electric Energy Systems

The primary thrusts of each of these Divisions are as follows:

The Buildings and Community Systems program focuses its attention on the development and acceptance of practical energy savings technology and more effective energy use in buildings, community systems and consumer products. I will develop this area further in my later testimony.

The Industrial Energy Conservation program is focused on improving the efficiency of industrial and agricultural processes and equipment. Specific thrusts include:

- 1. Waste Energy Reduction Reduce energy loss by improvements in equipment and process steps common to many industries.
- 2. Industrial Process Efficiency Examines integrated processes with energy intensive industries to assist in reducing total energy consumed.

- Agricultural/Food Process Efficiency
 Energy conservation in food/fiber chains associated with agriculture production/processing.
- 4. Technology Dissemination

Maximum utilization of technologies developed above.

The Transportation Energy Conservation program is focused on improved efficiencies of highway, as well as non-highway, transportation systems.

Specific thrusts include:

- Heat Engine Highway Vehicle System
 Develop Stirling Cycle and gas turbine in partnership with industry.
- Electric and Hybrid Vehicle Systems
 Determine the potential for electric vehicle performance and its future transportation role
- Alternative Fuels Utilization
 Identify best route for fuel substitution through RD&D to promote non-petroleum base fuels for transportation.
- Non-Highway Transport System
 Identify energy conserving projects and share in energy projects with DOT and Department of Commerce.

The Energy Storage Systems program is focused on providing technological research and support in areas of:

- Batteries
 Develop advanced batteries for utilizing load leveling and automotive propulsion applications.
- Chemical Storage Systems
 Technologies to utilize concepts such as hydrogen production,
 storage to supplement Nation's energy supplies.

- Thermal and Mechanical Storage Systems
 Research, development and demonstration of flywheels, compressed air storage and hydros
- 4. Technical and Economic Analysis Supports R&D demonstration of energy storage technologies described above.

The Conservation Research and Technology program is focused primarily on energy conversion research with major emphasis on:

- Fuel Cell Technology
 Addresses direct conversion from chemical energy to electrical energy.
- Heat Cycle Technology
 Conversion of thermal energy to mechanical energy and electric energy.
- Combustion Technology
 Conversion of chemical energy to thermal and radiant energy.
- 4. Advanced Concepts and Components Development of advanced gas turbine for electricity generation and initial commercialization; addresses improved component efficiency as applicable to electrical utilities and energy intensive industries.

The Electric Energy Systems program focuses its efforts on the electric utility industry with research being performed on:

- Bulk Power Delivery
 Concepts and hardware having potential for improving transmission efficiency and reliability.
- Systems Structure and Control
 Development of electric energy systems having structure and controls to ensure viable and efficient future systems.

- New Technology Integration
 Develop methodologies and theory and the dissemination of such -to industry and other Federal agencies.
- 4. Field Test and Evaluation Moving emerging technologies from lab to power system environment. The primary area of interest for today, as I understand it, is concerned with those activities undertaken in the Division of Buildings and Community Systems.

The objectives of the Buildings and Community Systems programs are to establish and maintain national technical leadership in the conduct of research development and demonstration activities which accelerate and/or complement those underway and planned in the private sector, and to foster acceptance of energy savings technology and more effective energy use in buildings, community systems and consumer products, with... minimum socio-economic and/or environmental impacts.

Our efficiency targets in the near term are to permit a decrease in unit energy consumption for an immediate savings on the order of 0.8 million Barrels Per Day Equivalent (BPDE) by 1980 and by 1985 to permit a decrease in existing buildings and community systems of 20% and in new buildings and community systems by 30% for a total projected energy savings of 2.4 million BPDE.

In the mid-term (by 2000) we hope to decrease energy consumption in existing buildings and community systems by 30% and in new buildings and community systems by 50% for a total projected energy savings of 4:1 million BPDE.

The overall strategy for achieving these goals working with FEA, DOC and other Federal agencies will be to:

- Encourage and support the installation of existing energy efficient technologies as soon as possible.
- o Develop and implement in the Federal sector new energy efficient technologies and appropriate institutional improvements.
- o Develop and commercialize systems which will reduce the dependence on petroleum and natural gas.
- Disseminate information about existing and new technologies concerning efficient energy systems.
- Accelerate/complement private sector efforts in development of new technology.

We are embarking on four major technology development thrusts within the buildings and community systems program. These are:

- 1. Architectural and Engineering Systems
- 2. Community Energy Technology
- 3. Urban Waste Technology
- 4. Technology and Consumer Products
- 1. Architectural and Engineering system program encompasses RD&D to develop technologically advanced energy savings measures for use in both commercial and residential buildings. Research is being performed to lead toward the development of performance standards to be utilized by the buildings industry and State and local governments. In FY 1976 and FY 1976T we executived 22 contracts and expect to obligate \$6,000,000. Our FY1977 obligations are estimated to be \$10,175,000.

Typical projects include:

- o Energy Use in office buildings
- o Energy conservation in restaurants and supermarkets, hospitals, schools

- o GSA Energy Conservation Demonstration (Manchester)
- o Annual Cycle Energy Systems (ACES)
- o Minimum Energy House
- o Research for performance standards in new buildings
- o Innovative financing.
- 2. Community systems research, development and proof-of-concept expermentation is performed to evaluate the role in community development for integrated utility systems, urban density/energy relationships, zoning and land use patterns and innovate approaches and technologies to determine and demonstrate the optimal community design patterns from an energy viewpoint. In FY 1976 and FY 1976T we executed 18 contracts and expect to obligate \$3,400,000. Our FY 1977 obligations are estimated to be \$6,860,000.

Typical projects include:

- o Advanced technology mix energy system
- o District heating and cooling systems retrofit
- o Ekistic energy community model
- o Land use and energy
- o Comprehensive community planning
- 3. An additional aspect of the Community Systems program is in the area of urban waste technology research, development and demonstration for recovery of energy from urban wastes. We are working closely with . Environmental Protection Agency (EPA) on this and have executed an Interagency Agreement (IAA) with them. In FY 1976 and FY 1976T we executed 19 contracts and expect to obligate \$4,500,000. Our FY 1977 obligations are estimated to be \$4,650,000.

Typical projects include:

- o Bioconversion including anaerobic digestion and enzymatic hydrolysis
- o Pyrolysis
- o Direct combustion of waste
- 4. Technology and consumer products research to assure that technologically advanced energy savings measures are identified and developed for use in such areas as appliances and other consumer products; heating, ventilating and air conditioning systems; lighting systems; etc. Work is also underway to develop energy efficient materials for use in buildings. In FY 1976 and FY 1976T we executed 20 contracts and expect to obligate \$3,000,000. Our FY 1977 obligations are estimated to be \$4,300,000.

Typical projects include:

- o Integrated appliances
- o Water heater refit
- o Energy efficient light sources/ballasts (LITEK)
- o Insulating and optical materials
- o Advanced heat pumps
- o Building system controls

Examples of Specific Projects We Are Conducting Which are Related To the Design and Construction of Buildings Include:

Development of Performance Standards-

ERDA is working in cooperation with HUD, FEA, NBS, and others, to undertake the research necessary to develop and promulgate standards for new construction.

In FY 1976, a program for the development and dissemination of energy conservation standards for new buildings was initiated. Several evaluation activities were initiated and the research plan developed.

In FY 1977 priority will be placed upon research necessary to promulagate energy conservation standards for new buildings.

Annual Cycle Energy System (ACES)

The ACES concept is a house in which the energy requirements for heating are extracted from water by a heat pump. The water thus cooled is stored and used during the summer for cooling. This significantly reduces the energy input to the dwelling unit. This is a jointly funded project with participation from HUD, TVA, University of Tennessee and ERDA. The demonstration house utilizing the ACES concept and all the required monitoring and evaluation devices have been completed during FY 1976. The demonstration house is being dedicated this week in Knoxville, Tennessee.

In FY 1977 the actual operation of the ACES system will be conducted and all data collected will be analyzed for practical and cost-effective application potential on the commercial market place. Recommendations for further research, development and demonstration in housing and other buildings types will be promulgated. A market survey will be conducted by the National Association of Home Builders (NAHB) Research Corporation for determination of market penetration of the ACES concept in the housing market. Further testing of ACES will be extended in some cases by the private sector, for example in Richmond, VA and Philadelphia, PA.

Commercial size ACES applications will be explored by the Southern Interstate Nuclear Board (SINB) for selection of a state-owned office building utilizing ACES.

Minimum Energy House

ERDA funded research, development, design and construction of two "proof of concept" minimum energy conservation houses. The project is jointly sponsored by ERDA, the Southern California Gas Company and Mission Viejo Company (a Southern California major developer of new homes). During FY 1976 the two houses were designed and are now being constructed. They utilize the latest technology and hardware which results in energy savings in excess of 50% as compared to the usual project house at Mission Viejo and in a price range comparable to other houses.

During FY 1977 the evaluation will be completed and the results disseminated to the residential building industry.

Measurements and Analysis of the GSA Energy Conservation Demonstration Building in Manchester, New Hampshire

During FY 1976 the General Services Administration completed construction on a multi-story office building in Manchester, New Hampshire. It was designed to demonstrate energy conservation through proper building design and operation. During the design phase of the project, the National Bureau of Standards assisted GSA and its energy consultants in evaluating the effects of various alternative designs for the building. In FY 1976, ERDA financed the extension of that work including the development of measurements packages of the building's energy consumption performance; economic analysis; evaluation, installation and operation of a solar system; and several experiments on ventilation, air leakage, illumination, and human acceptance. The information from the demonstration and experiments will be available as design and operation guides for the new building construction, both in the Government and private sector.

Energy Related to Building Process

In FY 1976, the Center for Advanced Computation (University of Illinois) and Richard Stein, AIA of New York City, will be preparing a report on the energy used in the building industry for the construction of buildings. During FY 1976 this study traced the energy consumed in the production of building materials, transportation and handling, and placement in the final building location.

In FY 1976 the report on total energy consumption was completed and in FY 1977 a catalog of energy units required for each building type will be prepared for use by designers in order to determine the optimum energy efficiency.

Energy Conservation in Restaurants

In FY 1976 a contract was awarded to Sambo's Restaurant Corporation of Santa Barbara, California, for inclusion of the latest state-of-the-art energy conservation techniques in their fast food restaurant located in Albany, New York. During FY 1976 the restaurant was designed by Sambo's and Elsters, Inc., building permits were obtained, construction begun and completed.

The State University of New York, during FY 1977, will perform extensive monitoring and analysis of energy consumed as compared to similar standard Sambo's restaurants. Special features of the completed restaurants include capture and storage of waste heat, solar assist for hot water, and special energy conservation controls and ventilation and lighting system. Case histories developed based on the Sambo's data will be widely disseminated to the remainder of the fast food industry.

Design for Natural Thermal Storage

A contract will be signed during FY 1977 to investigate, analyze and recommend applications of natural storage of energy technology. Inadequate data is available on the natural storage of energy potential in conventional building products or subsystems of buildings. The research contract will include data collection, state-of-the-art survey, additional testing required, analysis of most cost-effective means of utilizing heat storage and recommendations on demonstrations of new technology or additional research required.

Food Stores

Of all the retail stores in operation in the United States none consumes more energy than the supermarket. Energy costs often exceed a store's rent or an entire chains net profit. During FY 1977 a project will be initiated to simulate energy conservation in supermarkets in order to establish a basis for engineering management and operation of supermarkets in all geographical locations.

The simulation will be constructed to recognize the important, complex relationship's involved in the basic controllable areas of building design, store equipment selection, operations and maintenance. Information for input will be from complementary programs maintained by the contractor and documentation from the supermarket industry.

In addition to the domestic RD&D efforts we are embarked on several programs for international cooperative RD&D. These activities are complimentary to and integrate with our domestic program. They are

accomplished through the International Energy Agency and the NATO Committee on the Challenges of Modern Society.

In the International Energy Agency we are particularly interested in the Energy Conservation R&D Working Group of which ERDA had lead responsibility. The fifteen-member Group currently has four major projects under investigation in the buildings area:

- o Thermal Characteristics of Buildings o Heat Pumps
- o Thermal Storage
- o Energy Cascading

For example, we have recently signed an Implementing Agreement with the Federal Republic of Germany on a cooperative research program on energy conservation in Buildings Complexes located in Wiehl and Eslingen in Germany. This program will allow us to receive the benefits of a \$5,000,000 research program for the expenditure of \$240,000.

In the Committee on the Challenges of Modern Society (CCMS) program, we are participating in the Rational Use of Energy Pilot Study program; one of nine currently active programs. The U.S. is serving as the pilot country for the program. The program addresses both the immediate short-term problem of fuel shortages accompanied by abrupt rises in energy costs, and the longer term problems of balancing energy supply and demand and resolving balance of payment difficulties.

We are presently coordinating a Clearinghouse on Energy Conservation in Buildings (W67) for the international exchange of information relating to energy conservation in buildings. We also review and assess the relative importance of particular technologies such as thermal insulation and solar energy. Additionally, we are involved in the Modular Integrated

Utility and Total Energy System (MIUS) study, which is developing a methodology for comparing the technological and economic efficiencies of integrated utility systems for communities.

To assist us in the selection of projects which will have maximum energy savings at least federal cost, we have developed and are implementing management and program evaluation methodologies. These will provide quantitative cost-effectiveness assessment criteria for individual energy conservation program evaluation and restructuring as appropriate. In FY 1976, threshold criteria and ranking procedures were developed, tested and implemented. In FY 1977, a resource allocation technique will be developed for evaluation of program alternatives for proposed projects, on-going projects, and those reaching completion under varying technological and administrative constraints. One use of such a technique, for example, would be to answer the question: "Given a series of projects which have met the threshold criteria, at a given budget level, what mix maximizes the savings in barrels of oil?"

The projects selected for funding in FY 1977 have been subjected to the Threshold Criteria procedures. In general all projects met the threshold criteria.

We realize that there are many Federal agencies who have a part to play in our achieving our energy conservation objectives.

Specific Interagency Agreements and/or management structures have been establish to carry out the ERDA programs in light of the needs and responsibilities of the other Agencies. Memorandum of Understanding have been executed by ERDA with numerous Agencies. Of specific interest

to the Buildings and Community Systems program are the Agreements with $\ensuremath{\mathsf{HUD}}$ and $\ensuremath{\mathsf{FEA}}$.

An IAA was executed with HUD for cooperative work in the Community Systems area. Specifically, HUD is transferring funds to ERDA to expand an ERDA activity related to energy and community design. HUD also provides management expertise and community design, as required. An IAA is also being negotiated with HUD which concerns a cooperative program for the development of energy efficient standards for new construction.

Other ongoing interagency activities include work being performed for ERDA by the NBS and a joint program of RDAD with the DDD.

An Interagency Task Force on Buildings Energy Conservation Research and Development was established by ERDA late in FY 1975 and continues to be chaired by ERDA. This Task Force meets on a monthly basis. Fourteen Agencies participate, and the monthly meetings have been an effective method to assist in focusing the ERDA program to meet the needs of user agencies; to update all parties on current major RD&D activities and legislative actions; and minimize unwarranted duplication of effort in the Federal establishment.

We also realize that we must maintain interfaces continually with all segments of the buildings industry including various financial institutions, consumer groups, etc. We are maintaining regular contact with organizations such as the National Governors Conference, League of Cities, American Society of Heating Refrigeration and Air Conditioning Engineers, American Institute of Architects, National Association of Home Builders, National Conference of States on Buildings Codes and Standards, building

industry, trade associations, and universities to get their input and feedback for our program.

We believe that there is a large potential for energy conservation in the buildings sector and that research must play a large part in achieving that potential.

However, research alone will not allow us to attain these goals.

The new technology must be commercialized for it to be effective.

There is currently available energy conserving technology which is languishing on the shelf for economic and capital shortage reasons or in some instances for lack of awareness of the technology.

There are other reasons why market forces are not operating as efficiently as they could. These include:

- Most individuals and some industries are unaccustomed to using life cycle costing as a basis for purchase decisions and tend to make decisions on the basis of lowest initial cost.
- Personal taste and value are often wedded to existing technologies.
- Vendors may be deterred from marketing a device because new and unexpected environmental standards might inhibit the use of a technology before the investment for development and marketing can be uncovered.
- Even though a basic technology is available, manufacturers may have to overcome numerous other technological hurdles and some institutional hurdles to adapt the technology to particular markets.
- Potential users may be unsure whether the first generation of a technology will perform as advertised.

Nearly all of our current efforts in conservation RD&D (as well as in other programs like solar heating and cooling) are aimed at commercialization of new technology in a broad and diffuse marketplace. We are committed to the principle that the private sector and marketplace forces should be allowed to operate to the maximum extent possible.

Toward this end the Federal Government should provide leadership and assistance in those areas in which the private sector and marketplace forces acting alone would not allow the attainment of our national energy efficiency goals.

We believe that our RD&D program in the area of design and construction of buildings is moving forward in the direction of being able to provide the necessary Federal leadership to help us attain our energy conservation goals.

Mr. Chairman, I would be happy to answer questions of the Subcommittee.

[Submissions to additional subcommittee questions follow:]

ANSWERS TO QUESTIONS FOR MR. ECKERD

Question 1. On page 10 of your statement you say that a 10-year plan has been developed to retrofit 50 percent of your most energy intensive space. What percentage of all Federal buildings will this represent? How can you possibly retrofit these buildings with as little as \$140 million? To what extent will these

buildings have to be refurbished to make them energy efficient?

Answer, Overall, there are approximately 400,000 Federal buildings and facilities. Of these, GSA operates approximately 2,300 Government-owned buildings nationwide. The ten-year plan we developed calls for us to retrofit 50% of GSA space only, which equates to approximately 85 million square feet, by 1985, at a cost of \$140 million. We feel that by carefully choosing projects and buildings for retrofit we can complete the task within the estimated cost. To this end, we are selecting retrofit projects with a fast cost payback and we have limited the payback period for projects to be accomplished to 10 years, Retrofit opportunities and needs vary considerably from building to building. Some buildings may only require one or two minor modifications while others may require several major modifications. Therefore, each building must be examined and its individual characteristics taken into account for retrofit planning. Detailed surveys are expected to identify control improvements, timer use, heat recovery applications, and general improvements in building structure heat transfer coefficients that may prove applicable across the board. Energy management systems, including load shedding, are expected to be readily applicable in buildings having central control panels.

Question 2. Also on page 10 you say that 5 percent of your space will be "evaluated for retrofit" by FY 1977. Why can't you evaluate more than 5 percent?

Answer. We have established the goal of evaluating 5 percent of our space for retrofit by fiscal year 1977 to stay within the limits of the financial resources we have available. However, we do plan to expand this in subsequent years to around 10 to 12 percent per year. Another constraint in implementing the findings of these surveys is the funds available for this purpose.

Question 3. How many Federal buildings will actually be retrofitted in FY

1977?

Answer. It would be difficult to provide a precise number for buildings which will actually be retrofited for energy conservation in FY 1977. Already we have completed detailed engineering retrofit studies on 23 major buildings. Work is being programmed currently based on these studies. Our regions have initiated a number of small retrofit projects and we are installing energy management systems in some of our larger Federal buildings.

Question 4. Has GSA developed energy conservation standards which apply

to buildings leased to the Federal Government?

Answer. Energy conservation practices have been adopted for existing leased buildings which include delamping and the temperature adjustment program. New leases require the lessors to use the same energy conservation practices as adopted for government owned buildings. In buildings constructed for lease to the government which exceed 75,000 square feet of space, the design criteria is essentially comparable to that in the design of government owned buildings.

Question 5. Have you studied the energy conservation ramification of the location of new Federal buildings, for example near airports, residential areas,

etc.?

Answer. GSA is required to observe a number of legislative and Executive requirements in locating new Federal buildings. For example, Executive Order 11512 requires the consideration of availability of low and moderate income housing, adequate access from other areas in the community, adequacy of parking and the impact the new Federal building would have on the community. Energy conservation as it relates to the above is also considered.

Question 6. Are the 49 new Federal buildings under contract by GSA being built out of the most energy efficient materials available and equipped with energy

saving technology?

Answer, The 49 new construction and major alteration projects currently underway are being designed for reduced energy usage. GSA's approach to reducing the energy required annually to operate a new building is set forth in our Energy Conservation Design Guidelines for New Office Buildings (copy attached). The Guidelines are performance rather than prescriptive oriented. They establish

a stringent energy budget/goal for the annual operation of the building rather than requiring specific amounts of insulation, limits on window sizes, etc. Various energy saving opportunities are listed in the Guidelines, with priorities for vari-

ous climate zones, to assist the designer.

The question of using the more energy efficient materials in the construction of buildings has been considered by GSA. It was found to be very complex. To date, we have found no practical way of addressing the question directly. The question is addressed indirectly by cost competition. During the past few years, energy costs have become a very significant portion of the total production cost of most materials and also a significant portion of transportation costs. Since materials and construction projects are procured on the basis of low bid, the energy efficient producer or the producer having high transportation cost to the job site tends to be eliminated.

Question 7. What portion of the 30 percent reduction in energy use in Federal establishments is attributable to limited use of military equipment, ships and the

like? What portion is attributable to DOD?

Answer. The 30 percent reduction we mention is only for GSA-controlled facilities and does not reflect changes in use of military equipment, vehicles, ships, or planes. The Department of Defense (DOD) manages and reports on their facilities. They reported to the Federal Energy Administration (FEA) that they had achieved a 26.1 percent reduction for FY 1975 over FY 1973.

Question 8. Is the Manchester, New Hampshire, Federal building demonstration

project being built of the most energy efficient materials?

Answer. The new Federal Building, nearing construction completion in Manchester, New Hampshire, was designed for high energy efficiency. It is expected to operate with 40 to 50 percent less energy consumption than typical modern office buildings of similar size and subjected to the same climatic conditions. (With respect to use of the most energy efficient materials, see the answer to question 6.)

Question 9. Has GSA experimented with multiple use of Federal buildings as an

energy saving device?

Answer, GSA has only limited experience with multiple use buildings. A very few buildings, mostly leased, include commercial retail space on the lower floor. Construction of buildings designed for multiple use would require enabling legislation. The Senate has approved the Bill S. 865 which authorizes GSA to construct such buildings. A similar bill is being considered by the House of Representatives.

Question 10. Wasn't the FBI building originally designed as a multiple use

building?

Question 11. Why isn't it being used as one?

Answer. Though the possibility of including multiple use facilities was discussed, there were never any designs for the FBI Building involving multiple use.

Question 12. Are your Federal energy conservation guidelines, mentioned on page 5 of your statement, mandatory for all existing Federal buildings? Why not?

Answer. The full title of the document mentioned on page 5 is "Energy Conservation Design Guidelines for New Office Buildings." It is not suitable for mandatory application to existing buildings. However, we are concerned with our large inventory of existing buildings. Therefore, companion documents have been prepared to assist in our efforts to conserve energy in existing buildings. These two companion documents are "Energy Conservation Guidelines for Existing Office Buildings" which deals primarily with retrofit opportunities and "Energy Conservation Guidelines for Building Operations." (Copies attached.)

Question 13. How many Federal buildings have been equipped with solar

heating and cooling systems?

Answer. To date, contracts have been awarded to install solar energy systems on four GSA controlled (or constructed) federally-owned buildings. Three of these buildings include solar systems which will provide supplementary heating, cooling and domestic hot water. One small system will provide only heating for domestic hot water. None of the four installations is in service. However, three of the installations should be in service within four months. In addition, one building currently under construction for long term lease by GSA will have supplementary solar heating, cooling and domestic hot water. Other solar system installations are planned.

Question 14. What is your estimate as to when we can expect all Federal buildings to be retrofitted for energy conservation? How much will this cost?

Answer. We estimate that almost all Federal buildings and facilities, including those operated and managed by other agencies, will be retrofitted to some extent in 15 to 20 years. It would be very speculative to estimate the cost since our experience in retrofitting special purpose buildings is limited.

ANSWERS TO QUESTIONS FOR MR. LEIGHTON

Question 1. On page 5 of your statement you outline efficiency targets for 1980, 1985 and 2000. Are these ERDA targets or Administration targets? Why doesn't ERDA have annual targets? Wouldn't that help gauge the success of your program?

Answer. These are ERDA targets.

Although energy savings are not presently expressed in the form of annual targets, ERDA routinely assembles estimates of the energy savings that will accrue year by year as a result of research, development and demonstration projects within the program. These project estimates are difficult to combine, because of the complex and highly nonlinear interaction between the various projects that form the total conservation program, but ERDA is accomplishing the combination of the estimates through modeling activities under way at Brookhaven National Laboratory and Oak Ridge National Laboratory.

The Division does indeed expect that relating the total expected impact of all projects taken as a whole, to the goals of 1980, 1985 and 2000 will be a useful procedure. It should allow closer correlation and tracking between expected project results and national energy savings goals, to allow for optimal selection

of RD&D priorities.

Question 2. With the great potential for energy conservation in this country, I don't understand why ERDA's targets are so low, A 800,000 barrel per day equivalent energy savings by 1980 is peanuts. Would you explain? What percent-

age of our total energy use would be saved by 1985?

Answer. This level of energy savings, 800,000 BPDE by 1980, is attributable only to ERDA-sponsored energy conservation RD&D projects within the scope of the program of the Division of Buildings and Community Systems. Energy savings attributable to the entire energy conservation program, including transportation, utilities, etc., are of course larger.

Energy savings projected for 1985 are approximately 25% of energy consumption within the buildings sector. The other sectors have similar energy savings

goals, as appropriate in each case.

Question 3. On page 10 of your statement you mention ERDA's involvement in the construction of "minimum energy conservation" demonstration houses with Mission Viejo Company in California. (1) Are these homes built? (2) Have they been evaluated? (3) Was the energy efficiency of materials used in them considered at all? (4) What did they cost to construct? (5) When will they be marketed? (6) What will they cost the consumer?

Answer. (1) The houses referred to are Minimum Energy Dwellings (MED) rather than "minimum energy conservation dwellings" as stated, the distinction

being between consumption and savings.

The two MED houses are nearing completion and will be dedicated the week of September 20, 1976. (2) The two houses, one occupied and one vacant, will be monitored with data collection devices and the results analyzed and compared to a similar house without the special features in the same subdivision. (3) The energy efficiency of materials used in buildings is being studied in another ERDA contract with the University of Illinois. (4) The ERDA share of the total project is \$230,000, while Southen California Gas Company is spending \$247,000 and the Mission Viejo Company, \$141,000 for a total shared project cost of \$618,000. The actual construction cost only is less than this amount and is required to be reported to ERDA within 60 days of project completion. (5) After the conclusion of the contract, the homes will sell for \$42,000 to \$44,000 without the special MED features, and the extra costs to the customer have not yet been determined.

In undertaking any of our research projects, environmental impacts and technology assessments will be produced, which among other things relate energy used in the building to the building process and choice of building materials.

Additional information on this project follows below:

The Mission Viejo project (jointly funded by ERDA, the Southern California Gas Company and the Mission Viejo Company) is not directed at the demonstration of existing technology in the abstract, nor is that demonstration aspect the primary one of the project. The project, rather, is directed at analyzing, evaluating and developing technical data concerned with the following:

a. Preparing and validating an equipment selection procedure and handbook, which can then be marketed by FEA, based on new criteria being developed as part of this project. The criteria are concerned with selection and sizing equipments based on realistic high probability simulation of annual weather data, and to account for thermal lags of interior conditions due to exterior weather changes due to the natural "fly-wheel" effect for all buildings. At present for residential space, equipment is sized on a single design temperature for heating or cooling and degree day techniques. These selection criteria tend to oversize equipment and thus result in energy inefficient operation. We believe the method being developed under this program will result in energy savingsand hence dollar savings for the consumer-and can be reduced to a handbook readily usable by builders and heating contractors. The technique will be validated in the course of the project.

b. Site design techniques will be established and evaluated which maintain the density of dwelling units initially planned for, yet allow for energy efficient orientations to be maximized for various styles of houses and various equipment selections. Although styles vary throughout the country, the methodology

will be documented for use elsewhere.

c. Consumer preference in equipment as well as architectural design will

be evaluated.

d. Undertake detailed evaluation of actual performance of technical options which are or could shortly be commercially available. These evaluations will allow builders, utilities and financial organizations, working together, to offer and finance such options which reduce energy consumption with minimum increases in the monthly cost of housing. A major part of the ERDA contribution to the project is for instrumentation, data collection and analysis. The equipment and energy conservation design features being evaluated include:

1. Value of 2×6 framing and increased wall insulation in a warm/dry climate. The data obtained will be compared with the existing "Arkansas House" built in Merriam County, Arkansas (across the Mississippi River from Memphis, Tennessee), and one being built at the Brookhaven National Laboratory. The three projects will provide data for a spectrum of climatic conditions.

2. Value of adding mass to the roof.

3. Evaluation of technical efficiency and consumer preference for double glazing with Mediterranean style operable shutters between the panes of glass.

4. Evaluation of the savings and cost benefits which can be attributed to the economizer air conditioning cycle for single family homes.

5. Evaluate new techniques and ultimate performance of applying exterior stucco over a membrane to reduce infiltration. 6. Eva'uate energy savings and consumer preference for vertical ribbing to

shade windows. 7. Evaluate the performance, energy and perceived indoor air quality, of selective appliance venting, i.e., vent outside during air conditioning season, inside during heating season.

8. Evaluate energy savings and cost benefits for solar assisted hot water heating, space heating, and space cooling.

9. Evaluate cost benefits of heat recovery and storage.

10. Other features which will be evaluated in the context of a house as a system include water flow controls, selective exterior paints, foundation insulation, etc.

Another important aspect of the project is the evaluation of the feasibility of resource conservation for building materials. For example, the demonstration houses have been dimensioned such that no trimming is required of standard lengths of lumber delivered to the job site and that carpeting (generally petroleum based synthetic fibers) can be used in standard widths.

Question 4. On page 11 from your statement you mention that a report is being prepared for ERDA on energy used in the building industry for construction of buildings. Does this study include energy consumed by workers going to and from

the construction site?

Answer. The study considers the transportation of materials during the process from the raw stage to the finished in-place stage. However, the transportation energy consumed by workers cannot be determined due to the wide variances in distances from the job and job location, i.e., urban area with mass transit versus suburban area. Preliminary indications are that the energy accounted for by workers traveling to and from the construction site is small compared to energy consumption in the building during its lifetime.

Question 5. Has ERDA funded, or does it plan to fund in fiscal year 1977, any other studies on building construction conservation? Do you have any studies or demonstrations under way on the multiple use of buildings, as an energy saving

device?

Answer, A broad range of RD&D programs has been undertaken to determine the best techniques for energy conservation in building construction. The following lists projects that have either been funded by ERDA or will be in FY 1977, according to present plans, which include aspects relating to building construction conservation:

Decision Making in the Building Process—AIA Research Corp.

Energy Utilization in the Bui'ding Process—University of Illinois.
 Energy in Office Buildings—Tishman Research Corp. and Syska-Hennessey.

4. Energy in Restaurants-Sambo's Restaurant/N.Y. State.

5. Energy in Municipal Buildings-Aerospace Corp. and Jersey City.

6. Energy in Hospitals with HEW, VA and DOD.

7. Application of ACES to office buildings—Southern Interstate Nuclear Board. 8. Energy Used in Schools—with HEW and various school associations.

9. Energy used in Food Stores—contracts to be selected.

- Energy used in GSA Building at Manchester, N.H.—NBS.
 Site Analysis at Argonne Facilities—Pope, Evans and Robbins.
- CIB W-67 Commission—Building Research Advisory Board.
 Public Domain Computer Program—ERDA National Labs—LBL/LASL/ANL.

14. Minimum Energy House-Southern California Gas Co.

- 15. ACES in Single-Family Homes—Oak Ridge National Lab. and the National Association of Home Builders.
- 16. Strategies for Incorporating Energy Conservation in Housing—Hittman Associates.
- Energy Factors in Calculating Concrete and Masonry Wall Construction— National Concrete Masonry Association.

18. Thermal Standards Program-NBS.

The content of these projects range from considerations of energy consumed in the fabrication of building materials and their impact on thermal storage in buildings to the consideration of different approaches to building construction including the use of mechanical systems within buildings in order to conserve energy. The investigations of different building types, from restaurants to schools, hospitals and other institutions, will examine problems inherent in those generic structural types which must be resolved for optimal energy conservation.

Multiple building uses

In the planned studies of schools, we contemplate intensive research in energy conservation in buildings which provide multiple uses of buildings serving the community. For example, we expect to determine energy conservation techniques in the use of buildings used for teaching during the day and for other community purposes, such as hobby and craft shops, town and club meetings, adult recreation (including gymnasiums and pools) and similar activities in evenings and on weekends.

Question 6. On Page 13 you mention that ERDA is doing some work on heat pumps. Were you aware that FEA completed a marketing study on heat pumps eight months ago? Why is ERDA involved when heat pumps are an existing

technology-isn't this FEA's area?

Answer. ERDA's heat pump program picks up where FEA's leaves off. The FEA study on heat pumps completed by Gordian Associates examined the energy effectiveness, reliability, and marketability of residential air-to-air electric heat pumps. This study examined approximately one-third of the total heat pump's applications.

applications.

ERDA's heat pump program is being initiated by a study to investigate the state of the art of the balance of the heat pump's applications not studied in the FEA study. This new study will indicate the present day heat pump's weaknesses and identify where private sector R&D is being performed to eliminate these weaknesses. Projections will be made as to the energy savings that will result when more efficient heat pumps are being manufactured and used. Estimates will

be made of the new high-efficient heat pump product entry dates with and without a Federal heat pump RD&D program. Initial estimates indicate that a Federal heat pump RD&D program will accelerate the entry of new energy conserving heat pumps into the market place by 2 to 5 years and could save 292 million BOE by 1985.

Specific areas where RD&D efforts should be focused are in the development of more effective heat transfer devices, four-way switching valves, defrost controls, part-load performance, and the reduction of initial cost for heat pump

systems.

ERDA is addressing the problem of future heat pump RD&D work. FEA is primarily concerned with accelerating the commercialization of present-day heat pumps where they will make a significant contribution to rational energy savings. As an example, ERDA is sponsoring a project for a thermally activated heat pump with Consolidated Natural Gas. This heat pump would represent a striking technological advance over heat pumps presently on the market.

Question 7. On Page 2 of your statement you say that "The Buildings and Community Systems program focuses its attention on the development of practical energy savings technology . . ." What do you mean by practical? Isn't this a narrow focus for an agency that is supposed to be seeking out and testing

new energy ideas?

Amswer. By practical we are emphasizing research and development of energy conservation applications to buildings which is usually within the scope of near term technology. These technologies many times have great energy saving potentials, but have not, due to current development of the industry and the past availability of low cost energy, been applied to our Nation's buildings. It is this applied research as well as the development of new energy saving procedures and design that we are undertaking. Although there is an emphasis in the program now on near term technology, we are keeping an effort going to bring to fruition longer term technology.

There are two criteria that must be satisfied at a minimum, for projects considered for ERDA support: (a) energy savings must be significant on a national scale so as to make a meaningful contribution to national energy savings goals, and (b) such energy savings must be achievable in cost-effective ways, so as to create the commercial climate in which the energy saving technologies can

become practical in the sense that they are commercially viable.

Question 8. What energy conservation criteria are you applying in the location

of ERDA regional offices?

Answer. One of the major objectives in locating ERDA centers is to make them accessible to a wide variety of State, Federal and local organizations, as well as other Federal regional offices. OMB has a policy for the location of Federal field offices which ERDA attempts to adhere to where possible. ERDA locates ERDA centers and operations offices near major facilities such as national laboratories and additionally locates satellite offices in a nearby Federal regional city.

Although the principal historical reasons for locating ERDA regional offices had little to do with energy conservation specifically, we have been lucky in evolving a distribution of facilities that is consonant with energy conservation goals. Accessibility and decreased travel requirements will continue to be a

major factor in the selection of locations for ERDA centers.

For example, the Oak Ridge Operations Office is located near the Oak Ridge National Laboratory, with a satellite office located in the Federal regional city of Atlanta. The San Francisco Operations Office is located in Oakland, near to both the Lawrence Livermore Laboratory and the Lawrence Berkeley Laboratory, and in nearby San Francisco is a satellite office for aspects of ERDA operations that are of immediate concern to the public.

Question 9. Has the Federal Government developed a coordinated energy conservation plan, with definite energy saving goals, which could guide Federal

energy conservation efforts in this country?

Answer. The current plan for energy conservation is embodied in the publication ERDA-76, relevant portions of which are attached. A more comprehensive energy conservation plan is currently under development in ERDA's Office of Conservation Planning and Analysis, and will focus primarily on balancing the opportunities for energy savings, among all important end-use sectors.

A completely coordinated conservation plan which involves ERDA's end-use conservation programs, the energy productive sector and other important sectors, is being developed under ERDA's Assistant Administrator for Planning

and Analysis.

Question 10. Yesterday, Mr. Leo Daly told this Subcommittee that if all the Nation's buildings which are projected to be in use in 1990 were converted to energy efficiency buildings, we would save an equivalent of over 12 mildon barrels of petroleum per day. Do you agree with this estimate? In your estimation, is this goal achievable? If not, then what are we going to have to do to realize such a saving by 1990?

Answer. The specific saving objectives, for the near term and mid term have

Answer. The specific saving objectives, for the near term and mid term have been defined in "Creating Energy Choices for the Future" ERDA 76, Volume 2. There will also be savings immediately from this program (now to 1980). The

specific energy saving targets are:

Immediate (1980): To effect a decrease in energy consumption for immediate annual savings on the order of 0.8 million BPDE.

Near-Term (-1985):

To permit a decrease in energy consumption in existing buildings and community systems of 20 percent and in new buildings and community systems of 30 percent, for a total projected annual energy savings of 2.4 million BPDE.

To promote the development of more energy efficient household, commercial and recreational appliances and equipment to achieve a reduction in the energy consumption of consumer products.

Mid-Term (-2000):

To permit a decrease in the unit consumption of energy in existing buildings and community systems by 30 percent, and in new buildings, community systems and consumer products by 50 percent, for a total projected annual energy savings of 4.1 million BPDE.

To develop and demonstrate conservation technology and effect institutional changes to aid the widespread utilization of solar energy for heating and cooling buildings, thereby reducing the otherwise required consumption

of nonrenewable resources by 12 percent by the year 2000.

Future energy consumption in buildings will rest on more than one factor. Several are involved: (1) the energy efficiency of new structures, (2) how many new buildings are constructed, (3) the care given to the operation of our total building inventory (private, government, industrial), and (4) the effort we apply to refitting existing buildings. None of these areas of energy management can be forgotten if we are to maximize our savings.

A NATIONAL PLAN FOR ENERGY RESEARCH, DEVELOPMENT AND DEMONSTRATION: CREATING ENERGY CHOICES FOR THE FUTURE 1976

CHIEF PROGRAMMATIC THRUSTS

Because Volume II of the Plan is designed to present programmatic efforts in considerable detail, the remaining section of this chapter concentrates on those broad areas critical to achieving energy goals. For most of the high-priority programs to be pursued in the near- and mid-term, these critical areas involve: (1) accelerating the market penetration of energy supply and conservation technologies in or entering commercial status; and (2) ensuring the environmental acceptability of these technologies (including health, safety, social, and aesthetic factors). For high-priority programs in the longer term, i.e., chiefly those for the essentially inexhaustible energy sources, the critical area is identifying and overcoming technical and environmental problems in the earlier research, development, and demonstration program phases.

In each of these two groups, the Plan considers:

The critical problems of each technology that prevent market penetration and environmental acceptability for the near-term and technological success for the longer term programs. The former aspects of technology development tend to be the ones that have received the least attention in the past, are likely to pose the greatest hurdles to be overcome, and will require the closest coordination between the government and the private sector. Consequently, they receive more extended treatment in the technology discussions,

The strategic approach to be taken by the government—within the context of the Plan—and the larger, complementary role the private sector is expected to play. Each technology requires a program designed to meet its particular development needs. As discussed in Chapter I, a government role is justified under selected conditions—e.g., when a low or uncertain level of private return on investment bars private action even though significant social (public) benefits could be achieved, or where the rate of implemen-

tation of the private sector would desirably be accelerated through assistance in addressing key uncertainties and/or institutional obstacles. If the Nation's overall efforts are to mesh effectively, each sector needs to understand the current approach to introducing the technologies and the roles expected of each.

The specific programmatic efforts being considered or already under way to implement the strategic approach. In some areas, current efforts are extensive; in others, they are minimal in the expectation that normal market forces will cause the implementation of the technologies; and, in still others, efforts are contingent on interim results, further analysis, or negotiations between the government and private firms.

In the discussion that follows, the seven high-priority technologies becoming available in the near- and mid-term are addressed before the three longer term technologies. The order of presentation is:

- 1. Conservation
- 2. Light water reactors
- 3. Enhanced oil and gas recovery
- 4. Direct coal utilization
- 5. Synthetic fuels
- 6. Geothermal
- 7. Solar heating and cooling
- 8. Breeder reactors
- 9. Fusion.
- 10. Solar electric

Additional detail on these and other Federal Technology efforts is presented in Volume II of this Plan being published separately.

CONSERVATION TECHNOLOGIES

In the aggregate, conservation technologies—i.e., those permitting a more efficient use of energy—will contribute substantially to balancing the domestic energy supply and demand. ERDA-48 estimated that full implementation of more efficient technologies would permit continued economic growth without increased levels of imports through 1985; by the year 2000, such technologies would permit total energy consumption to be 25 percent less than it would be without their adoption (Scenario 1 of ERDA-48). Moreover, many of these technologies can have a more immediate—i.e., within 5 years—impact than those discussed later.

It must also be recognized that conservation technologies provide a potential cost-effective alternative to development of more supply technologies—i.e., in many instances, it will cost less to save a barrel of oil (e.g., through more energy efficient home heating) than it will to develop a new barrel of supply. This conclusion was suggested by the conservation scenarios of ERDA—48 (see Appendix B), which indicated that national energy needs could be met at lowest cost by employing improved efficiencies in end-use. Although these scenarios were not able to reflect the costs of modifying end-use installations, the large difference in total costs among scenarios indicated that ample financial margin exists to cover these additional costs and still provide a low-cost solution. Moreover, the barrel saved will make more of the finite resource available for future needs.

Finally, these technologies generally will help meet energy needs with the least adverse impact on the environment. Specifically, as conservation actions reduce energy consumption levels, pollutant emissions and disruptions will be decreased because of reduced energy extraction and transportation activity, reduced fossil-fuel combustion, and the lessened need for disposal of waste heat and other materials. In addition, reduced energy consumption will extend the availability of fossil energy resources and allow time to develop technologies that use inexhaustible energy sources (e.g., solar, fusion, breeder reactors).

The advantages of conservation technologies are expressed generally above. The rate of application and introduction of conservation technologies in specific instances will be determined by the comparative economics and social acceptability of the available alternatives.

Many of these advantages were recognized in the recent enactment of the Energy Policy and Conservation Act. The stated purpose of the Act is to "reduce domestic energy consumption through the operation of specific voluntary and mandatory conservation programs."

The key conservation technologies under consideration differ significantly from supply technologies discussed later in this chapter. Specifically, their number,

their diversity, and the relatively small energy contribution of any one preclude a single approach; rather, a broadly conceived strategy is needed. The nature of the conservation technologies ready for market penetration, the problems to be surmounted to gain adoption, and the broad-based strategy for facilitating their penetration of the market follow.

THE OPPORTUNITIES

The Nation has manifold opportunities for greater efficiency in the use of energy. Many are sufficiently developed to permit their rapid market penetration.

They fall into four groups:

1. Industry conservation.—The industrial sector currently consumes 40 percent of the Nation's energy. Reduction of this level of energy consumption will require a systematic evaluation of the industrial processes involved and a determination of those processes in which increases in thermodynamic efficiency can be achieved. Industry has made substantial progress in this regard, but more remains to be done. A host of more efficient technologies—some specific to individual industries and others applicable to many industries—is known. Many of these promise efficiency improvements of more than 30 percent. By implementing the successful results of RD&D, projected industrial energy consumption can be decreased by up to 17 percent per unit of output (equivalent to 1.8 to 2.7 million aggregate barrels of petroleum equivalents per day (BPDE) by 1985).

Some of these more efficient technologies:

Intermediate temperature heat pumps to minimize primary fuel consumption

Brayton cycle turbine generators to produce electricity from the thermal

discharge of furnaces (e.g., aluminum smelter or glass kiln) Heat transfer/thermal storage techniques to cascade energy flow within process industries

High temperature insulation/refractories Waste heat recuperators and regenerators.

2. Buildings conservation.—Commercial establishments and residential housing, which consume 29 percent of all energy in the U.S., present a number of opportunities to improve energy efficiency. Full understanding of these opportunities requires a systematic evaluation of essential factors associated with meeting a community energy needs. Three areas seem to hold large promise. First, a number of specific technologies exist-notably in insulation, shell design and heating, ventilating, and air conditioning—that need to be integrated and may require innovative marketing by industry to motivate consumers to accept and install them. Second, waste energy can be used more effectively in community systems. Third, some new technologies, such as the Annual Cycle Energy System,* appear promising but require further testing and/or development.

Implementation of the results of these RD&D efforts could save 2.0 to 2.8 mil-

lion BPDE by the year 1985.

3. Transportation energy conservation.—The transportation sector, which consumes 31 percent of total U.S. energy, can reduce its petroleum consumption by using proven technologies and by implementing well-studied operational changes, including:

Retrofitted aerodrag reduction devices on long-haul trucks Reduced horsepower losses on accessory drive for autos and trucks Use of drag reduction devices between freight cars on trains

New, energy-efficient engines for autos.

These improvements are expected to achieve savings of about 0.5-0.7 million BPDE by 1985.**

4. Electric energy systems.—The electric utility sector presently uses about 27 percent *** of all U.S. energy consumed. This percentage is expected to increase substantially in the years ahead. Significant energy savings-expected to be

^{*}Annual Cycle Energy Systems (ACES) for Buildings. A system potentially applicable to the residential and small commercial buildings market for space heating in winter and cooling in summer. Properly sized water storage tanks are incorporated in new building designs, including use of heat pumps. Heat is extracted from storage water in the winter; ice or chilled water in storage is used to cool in the summer.

**The savings envisioned are in addition to those currently being pursued by Detroit (e.g., lighter weight cars), but may be included by manufacturers in the efficiency improvements recently mandated by legislation.

**This 27 percent is included in the preceding three end-use sectors and is therefore nonadditive.

1.0-1.5 million BPDE by 1985—can be achieved by using improved equipment, and by altering consumption patterns, system structures and operations. Substantial capital and land savings and savings of oil can also be achieved. There are a number of opportunities for near-term savings, such as electric load management, application of energy storage, and removal of constraints to more efficient higher voltage transmission lines. A reliable electric energy system is also the critical link between advanced source technologies and end-use.

In addition to these opportunities, a continuing stream of new ideas and projects flows from the scientific community, individual inventors, and entrepreneurs. For example, recent private efforts have produced more efficient light sources and thermally activated heat pumps. Moreover, technological opportunities need to be considered in the light of alternative socio-economic-regulatory actions

such as standards and innovative financing.

MARKET BARRIERS

By and large, most of these conservation technologies will have to overcome problems of economic uncertainties, and normal resistance to the acceptance of new "products." Economic barriers will diminish as fuel prices rise and as more economical conservation technologies become available. For example, as fuel becomes relatively more expensive, end-users will be increasingly likely to invest in initially more expensive new technologies in the knowledge that overall (i.e., life-cycle) costs will be competitive for a given level of output. This "conversion" process will occur naturally but slowly within the market. In some instances the large, potential benefits may justify government action in the form of economic incentives or RD&D assistance.

In addition to the economic barriers there are several other kinds that must be considered in mapping implementation strategies. Specifically, end-users may be reluctant to invest in new technologies because they do not know whether the technologies will perform as designed, or whether they will be reliable; developers and manufacturers are sometimes reluctant to create new technologies because they do not know whether they can, in an acceptable time frame, meet the institutional tests posed by state and local governments, lending institutions, unions, and other key groups whose support is required to implement new ap-

proaches in literally every segment of society. For example:

1. Most individuals and some industries are unaccustomed to using life-cycle costing as a basis for purchase decisions, and tend to make decisions on the basis of lowest initial cost. If companies continue to make investment decisions solely on the basis of initial cost, some new technologies (e.g., long-life light sources, and integrated appliances for mobile homes) will fail to realize full potential.

2. Personal taste and value are often wedded to existing technologies. For example, the changes in home appearance caused by the installation of solar heating may be an important deterrent to some prospective buyers, and the "look" of low drag automobiles and trucks may impede their acceptance by

potential operators.

Vendors may be deterred from marketing a device because new and unexpected environmental standards might inhibit the use of a technology before the

investment for development and marketing can be recovered.

4. Even though a basic technology is available, manufacturers may have to overcome numerous other technological hurdles and some institutional hurdles to adapt the technology to particular markets. This effort may greatly compound the economic uncertainties.

5. Potential users may be unsure whether the first generation of a technology will perform as advertised. The problem is accentuated where the available technologies have not been sufficiently demonstrated. Potential consumers cannot afford operating fuel-saving products at a loss, especially when no significant

gain results from being the first operator of a new technology.

Finally, market penetration of conservation technologies may be impeded by a range of valid environmental, human health, and safety considerations. All new or modified energy related technologies must, of course, meet any existing pollution control requirements and many are required to meet new source performance standards. In improving energy efficiency in commercial establishments and residential housing through improved insulation or reduced ventilation, for example, the potential hazards of increased exposure to fine rarticulates from insulation or the effects on human health of reduced ventilation must be evaluated.

In addition, exotic technologies and/or fuels producing electricity may produce some negative environmental impacts. For example, higher temperature combustion will substantially increase certain types of emission (especially NO_x), higher temperature wastewater, and increase material deterioration. The use of certain fuels (e.g., nitrogen- and sulphur-bearing oils) in conjunction with high-temperature cycles will likely adversely affect air emissions.

On the positive side, quantification of the environmental benefits resulting from reduced energy consumption may help overcome institutional and social

barriers impeding large-scale conservation.

STRATEGIC APPROACH

In recognition of the need to address these general commercial and socioeconomic factors, the strategic approach to bringing a large number of conservation technologies into use in the near term incorporates five main elements:

1. A national policy conducive to the adoption of energy-efficient technologies.— An element of this policy is the enactment of the Energy Policy and Conservation

Act* which, in part, provides for:

A gradual removal of oil price controls, to encourage normal workings of

the marketplace-i.e., to increase supply and to reduce demand

Insuring the continuing progress in the improvement of automotive energy efficiencies, to ensure consumer adoption of more energy efficient automotive technologies

The identification of areas for improving the energy efficiency of major household appliances, to encourage consumers to make the most energy-

efficient choices

Working with energy-intensive industries, to encourage the adoption of

existing conservation technologies

Federal conservation efforts, to be carried out through procurement policies and through a 10-year plan relative to federally owned or leased buildings.

2. A 0- to 5-year planning horizon.—In addition to the near- (1985), mid- (1985–2000), and long-term (post 2000) planning horizons established by ERDA's enabling legislation, a new planning horizon—0 to 5 years—will be included in the annual energy RD&D Plan. Opportunities in nuclear, fossil, solar, and other technical areas will be included, although the predominant opportunities will probably be in the conservation program. Fuel substitution opportunities also will be sought because of the beneficial impact on oil imports and relief of gas shortages. This 5-year focus is intended to roll forward each year. The process will be institutionalized and monitored for successes and failures. The results of the initial ERDA review will be coordinated with other interested agencies, particularly FEA, to ensure a proper overall governmental approach is being designed and the best opportunities are being identified. Industry views will also be sought in this design phase to ensure that any government action assists and provides incentives to industry rather than result in preemptive, unneeded, or irrelevant government action.

Although some of these technological improvements will begin to appear in the marketplace between now and 1980, it may be cost effective for government to assist industry in accelerating their introduction and acceptance by the American

public.

3. Accelerated identification of promising technologies (narticularly within the 5-year horizon) and dissemination of information about their application in potential end-users.—For some time, FEA has had a program to identify conservation opportunities in industry, buildings, and transportation. Other involved agencies include the Cooperative Extension Service, Department of Commerce and Housing and Urban Development.

4. Integration of market and institutional barriers into the plans for developing the most attractive conservation technologies and for facilitating their implementation.—A general approach is being developed to consider implementation barriers at the inception and throughout the RD&D planning process. (See

Chapter V.)

5. Demonstration programs to work out the implementation details of more complex technological approaches.—Such efforts will most likely be needed in the highly fragmented building industry. Leading candidates for such programs include the Annual Cycle Energy System, integrated housing, and community

^{*}Public Law 94-163.

energy systems. Similarly, demonstrations of conservation technologies with broad industrial applicability may be justified. The appropriate government role in this area will be determined by further analysis of promising technologies and by socioeconomic research that diagnose barriers and the cost effectiveness of alternative approaches to overcoming them.

ACTION PROGRAM

The principal elements of a Federal program to carry out the strategy outlined above include:

Carrying out the provisions of the Energy Policy Conservation Act within Federal Energy Administration, and the Department of Commerce

Encouraging the private sector to implement conservation and fuel-substitution technologies within the 5-year planning horizon

Establishing a joint FEA and ERDA planning and implementation capability

Developing a capability for:

Identifying the energy-savings technologies that are attractive from the point of view of cost and implementation

Developing energy-consumption standards Identifying environmental costs and benefits Verifying technology capabilities Informing end-users about new technologies

Identifying and assisting in removing institutional obstacles

Carrying out demonstration programs as appropriate.

LIGHT WATER REACTORS

Although forecasts vary, most show nuclear power as a major factor in meeting U.S. energy needs by the end of this century. A typical forecast is for an installed nuclear capacity building from the present level of 39.6 millions of kilowatts of capacity (gigawatts-GWe) to 70-76 GWe by 1980, increasing to 160-185 GWe by 1985, 265-340 GWe by 1990, and 450-800 GWe by 2000.*

Industry and Government, in cooperation, have brought light water power reactors to their current status of safety and economic viability. As a result, this energy source presently supplies some 8 percent of U.S. electricity demand. Although several problems impede rapid market penetration (e.g., long lead times; evolving regulatory requirements; less than desired plant reliability and availability, a feature also shared with large coal plants, and high capital costs **), over 200 nuclear power plants have now been committed or ordered.

To bring the technology of light water reactors to full economic fruition several parts of the fuel cycle must be validated—technically, commercially and environ-

mentally. In brief, the areas requiring increased emphasis are:

Better definition (i.e., in terms of location, grade, extent, economics and availability) of recoverable domestic uranium resources

TABLE III-7

	Reserves 2	Potential	Total
Cutoff cost: 1 10 15 30	315, 000	1,000,000	1, 315, 000
	420, 000	1,620,000	2, 040, 000
	600, 000	2,900,000	3, 500, 000

Success in the transfer of responsibility for uranium enrichment to private industry and progress in initiating new U.S. capacity to meet future U.S. and overseas demand for enrichment services.

*Includes up to 60-80 GWe of breeders, assuming successful completion of the breeder

¹ Recovery cost per pound. 2 In addition, 90,000 tons of by-product is expected through 2000.

development program.

**Desoite higher capital costs, nuclear energy's lower fuel costs (compared with fossil fuels) allow power to be produced at a lower cost in most of the Nation. Only in those areas of the West, where abundant, low sulphur coal reserves can be mined cheaply is nuclear power not currently competitive. Of course such estimates depend on the accuracy of future estimates of both nuclear and coal costs.

A commercial fuel reprocessing and recycling capacity.

Demonstrated safe and environmentally acceptable waste treatment and storage and disposal processes and facilities.

Improved LWR technology. Strengthened safeguards.

URANIUM RESOURCES

If the use of light water reactors using domestic uranium resources is to expand as projected, an increase in the domestic uranium resources must also take place. Although uncertainties about the extent of uranium and the economics of its recovery exist, ERDA's present assessment (see Table 111-7, above) is that the reserve base is adequate to provide for all operating and planned power reactors (235,000 MWe) and to permit further growth even without the recycling of plutonium and uranium. However, currently identified economic-grade (\$30 or less per pound production cost) uranium resources may be inadequate to support the postulated long-term expansion of light water reactors beyond 1990 for their lifetime. Thus, additional major quantities of uranium resources of all grades must be identified and developed into reserves.

URANIUM RESOURCES-TONS OF URANIUM OXIDE (U308)

The necessary industrial commitment to exploration and expansion of production capacity to ensure adequate development of resources has been retarded. To identify areas favorable for uranium exploration, to assess more completely the resource base, and to improve exploration and extraction technology, a comprehensive government program, National Uranium Resource Evaluation (NURE) has been in progress for about 2 years. Under ERDA's direction, it is designed to provide a systematic and extensive survey of the conterminous U.S. and Alaska by FY 1981. NURE is expected to identify localities that appear favorable for detailed exploration.

[Whereupon, at 12:25 p.m., the subcommittee adjourned, to reconvene subject to the call of the Chair.]

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